RC Oehrle

5646

PRELIMINARY MANUAL

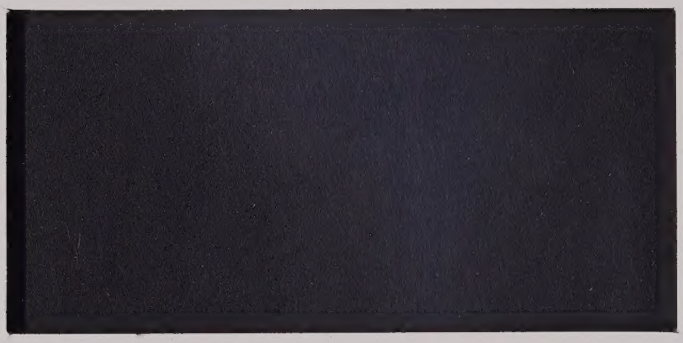
Series 4400*

DIGITAL MULTIMETERS
230 Module

DANA™

Dana Laboratories Incorporated
Irvine, California 92664

Telephone (714) 833-1234
Teletype 910-595-1136



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*For Model 4432, see Section 7

December, 1968

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SECTION 1

INTRODUCTION

1.1 INTRODUCTION

1.2. This manual describes the Dana Series 4400 Digital Multimeters (DMM). The basic models are the 4430 and the 4470 which differ only in their mechanical packaging. Model 4430 is a thin-line instrument (3-1/2 inches high) designed for standard rack mounting while Model 4470 is primarily a bench type instrument (see figure 1.1). Descriptions in this manual apply to all models unless otherwise indicated.

1.3 MECHANICAL DESCRIPTION

1.4. Each instrument consists of two modules. The Digitizing and Display Module, comprising the left-hand portion of Model 4430 and the upper half of Model 4470, contains the actual measurement circuits and is the same in all instruments in the series. The Accessory Module, comprising the right-hand side of Model 4430 and the lower half of Model 4470, contains signal conditioning circuits that provide a ten-volt full-scale (plus overrange) analog voltage for measurement by the Digitizing and Display Module.

1.5 This Manual covers Accessory Module 230 which provides measurement of DC voltages on full scale ranges of .1 volt to 1000 volts, AC voltage on full scale ranges of 1 volt to 1000 volts, and OHMS on full scale range of 1 Kohm to 10 Megohm. The combination of modules produce two DMM models designated as 4430-230 and 4470-230.

1.6 The power supply is common to the accessory and Digitizing Modules and is locates at the rear of the instrument. The Digitizing and Display circuits are located on a single printed circuit board. The signal conditioning unit consists of an isolator board and an ohms-AC Converter board. Circuits consist of integrated circuits except for critical analog circuitry where discrete components are used.

1.7. The output is displayed on a four-digit visual display with a fifth overrange digit that extends full-scale of each range by 20% (9999 to 11999). Automatic ranging is performed by internal circuits that determine the optimum range and switch to that range automatically.

1.8 ELECTRICAL DESCRIPTION

1.9 A block diagram of the DMM is shown in figure 1.2. For DC measurements, the input is applied to a voltage divider at the input that divides the input voltage by 1 or by 100 depending on the range selected. The scaled input is filtered and applied to the Isolator amplifier which delivers 10 volts full scale (12 volts, with overrange) to the Digitizing and Display module. The gain of the amplifier is either 1, 10, or 100 depending on the range.

1.10 For AC measurements, the AC Converter scales the input and rectifies it. The converter output is applied to the voltage divider (set to divide by one), filtered, then applied to the isolator amplifier, set to a gain of 10.

1.11 For Ohms measurement, the Ohms Conver-

ter monitors the output of the isolator to provide a constant current to the input terminals. The amount of current is dependent on the range selected. The DMM measures the voltage drop across a resistance connected between the input terminals. The input voltage is applied to the voltage divider (set to divide by one) and then applied to the isolator amplifier, set to a gain of 10.

1.12 The Digitizing and Display module measures the analog voltage from the Accessory Module by the high-accuracy ramp technique. The amplitude of the input signal is measured by comparing it to an internally referenced integrated step function or ramp. The DMM readout displays the position of a counter that measures the time required for the ramp voltage to reach the level of the input signal. The value displayed is equal to the voltage level of the input. Readings are taken four times a second with the OFF-ON-HOLD switch in the ON position. The HOLD position permits the instrument to remain at the last reading indefinitely. Reading accuracy of the DMM is maintained through the use of a crystal-controlled counter and a highly stable, zener-regulated, internal reference voltage.

1.13 SPECIFICATIONS

1.14 Specifications are listed in table 1.1.

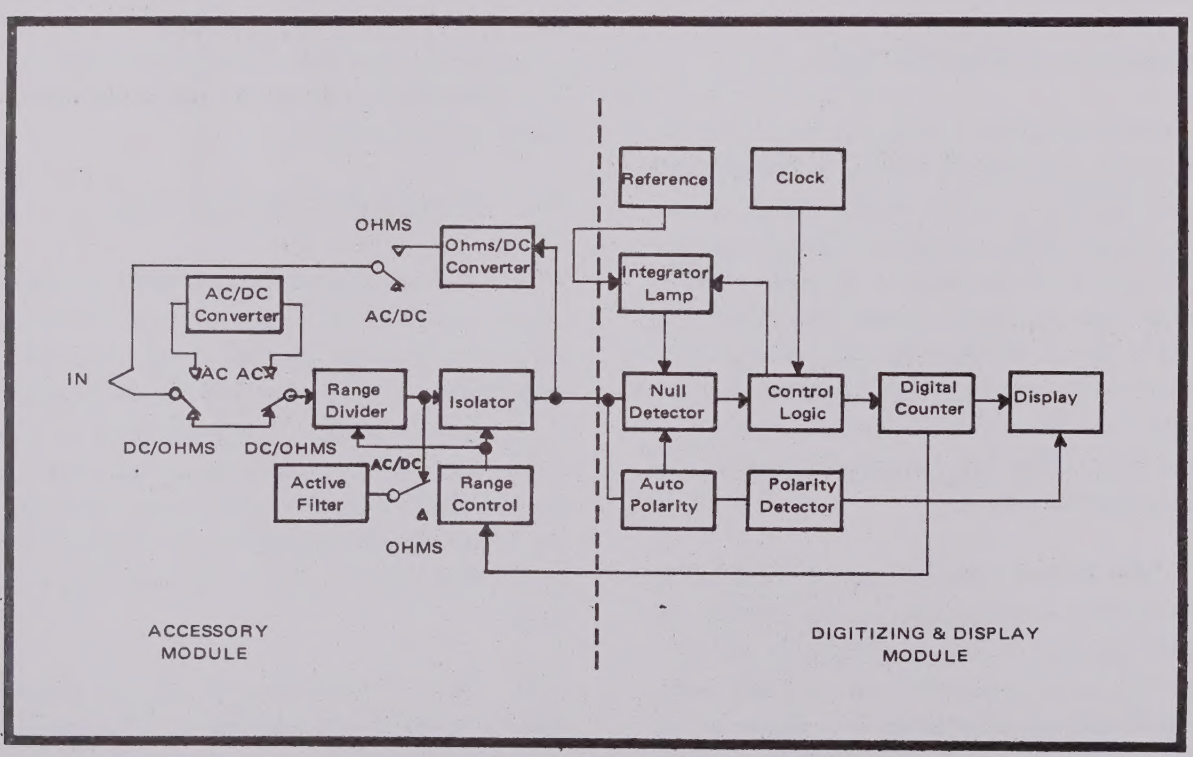


Table 1.1
Specifications

DC VOLTS:
Ranges (auto ranging & auto polarity): ± .12, 1.2, 12, 120, 1200 V (1000 V MAX)
Absolute Accuracy: ± 0.01% of reading ± 0.01% of F.S.
Resolution: 10μV
Noise Rejection (superimposed): 60 dB, 59 Hz and up; increasing 18 dB/octave, 80 dB min. to 10 kHz; 50 dB min. from 10 kHz to 100 kHz.
Common Mode Rejection: At dc, 100 dB (1 Kilohm in either lead)
At 60 Hz, 100 dB on .1, 1, and 10 volt ranges
100 dB on 100 volt range
100 dB on 1000 volt range
Input Resistance: 1000 megohms: 10 V range
100 megohms: 1 V range
10 megohms: 100, 1000 V ranges

AC VOLTS:
Ranges (auto ranging): 1.2, 12, 120, 1200 Vrms
Frequency Range: 50 Hz to 100 kHz
Absolute Accuracy: ± 0.25% of reading ± 0.05% of F.S.: 50 Hz to 100 Hz
± 0.1% of reading ± 0.02% of F.S.: 100 Hz to 5 kHz
± 0.5% of reading ± 0.05% of F.S.: 5 kHz to 20 kHz
± 2.0% of reading ± 0.1% of F.S.: 20 kHz to 100 kHz
Resolution: 100μV
Maximum Voltage Rating: 500 Vrms, 50 Hz to 10 kHz, decreasing to 100 V at 100 kHz
Common Mode Rejection: 60 dB, 61 Hz and below, with up to 1 kilohm in either lead
Input Impedance: 1 volt range: 2.0 Megohm ± 1%
10 volt range: 1.05 Megohm ± 1%
100 volt range: 1.0 Megohm ± 1%
1000 volt range: 1.0 Megohm ± 1%
Shunt Capacitance: Less than 100 pF

RESISTANCE:
Ranges (auto ranging): 1.2, 12, 120, 1200, 12,000 Kilohms
Absolute Accuracy: 1, 10, 100 ranges: ± 0.01% of reading ± 0.02% of F.S.
1000 range: ± 0.03% of reading ± 0.02% of F.S.
10000 range: ± 0.07% of reading ± 0.06% of F.S.
Maximum Voltage Across Unknown: 1.2 volts at full scale; maximum current 1 ma on 1 kilohm range

GENERAL:
Settling Time: 0.5 second, dc mode; 2 seconds ac mode
Maximum Common Mode Voltage: 250 volts
Measurement Rate: 4 per second
Warm Up Time: 1/2 hour to full accuracy
Operating Temperature Range: +15°C to +40°C
Power Requirement: 25 watts, 105 to 125 V (export 210 to 250 V), 50 to 400 Hz
Rack-mounting Hardware: Half-rack flanges (for Model 4470), Part No. 402660
Full-rack flanges (for Model 4430), Part No. 402588
Input Connector: Front standard; parallel rear optional (add -1 to model number)
Weight: 15 pounds (approx) net, 30 pounds (approx) shipping
Dimensions: Model 4430, 17 x 3½ x 14 inches; Model 4470, 8½ x 7 x 14 inches

CAUTION

TO AVOID DAMAGING THE INTEGRATED CIRCUITS, DO NOT REMOVE OR INSTALL MODULES WHILE POWER IS TURNED ON.

SECTION 2

INSTALLATION

2.1 UNPACKING AND INSPECTION

2.2. The 4400 series DMM is sandwiched between two forms of plastic foam and packed in a double-walled cardboard carton for shipment. The plastic forms hold the DMM securely in the carton and absorb any reasonable external shock normally encountered in transit. Prior to unpacking, examine the exterior of the shipping carton for any signs of damage. Carefully remove the DMM from the carton and inspect the exterior of the instrument for any signs of damage. If damage is found, notify the carrier immediately.

2.3. The 4400 series DMM, as shipped, is designed for bench-top operation. A standup bracket is provided under the case to aid in reading the visual display. The Model 4430 instrument can be adapted for rack installation with two flange mounting holes located in each of the two side panels. The rack-mounting kit (Dana 402588) is attached to the instrument by removing and discarding the four set screws occupying the mounting screw holes and securing the two rack mounting flanges to the side panels of the instrument with the four screws contained in the rack mounting kit.

2.4. The Model 4470 can be ordered from the factory as a half-rack instrument or the standard instrument can be returned to the factory for modification to accommodate the half-rack mounting hardware.

2.5 POWER CONNECTIONS

2.6. A standard eight-foot, three-wire, power cable is supplied with the instrument. This cord connects to a three-pin power connector at the rear of the unit.

2.7 INPUT CONNECTIONS

2.8. Signal input binding posts are located on the front of the accessory module. Connections to these terminals are made with standard "banana" plugs. Make connections as described under "Manual Operation", paragraph 3.2. Instruments designated by a "dash 1" (−1) following the model number are equipped with a duplicate set of input binding posts on the rear panel of the instrument.

2.9 INITIAL CHECKOUT PROCEDURES

2.10. The following procedure is performed to verify that no damage has occurred during shipment and that the instrument is operative. Slight deviations in readings during the following tests may be corrected by making simple adjustments. For instructions refer to Section 5, "Calibration". Any major discrepancies should be reported to the carrier and to Dana Laboratories immediately.

2.11. Prior to performing the checkout procedure, it may be advisable to refer to the operating instructions beginning with paragraph 3.2. Allow one-half hour for instrument to warm up before proceeding.

2.12 ZERO CHECK

(a) Select DC and 1 range.

(b) Short input leads. Visual readout should display 0.0000.

(c) If necessary, adjust ZERO control on front panel to obtain this reading.

2.13 POLARITY GAIN CHECK

(a) Select DC and 10 range.

(b) Apply a known voltage of approximately -10 volts to the input. Visual readout should display value of input voltage (within specified tolerance) and proper polarity.

2.14 RANGE CHECK

(a) Select DC and 100 range.

(b) Connect input to a source of +100 volts DC.

(c) Visual readout should display input value (within specified tolerance) and proper polarity.

(d) Vary input voltage and polarity; check for proper readout.

(e) Repeat the above four steps on 1000-volt range.

(f) Select Auto range and repeat the above checks.

2.15 AC Check

(a) Select AC and connect signal generator to input. Set generator to 50 Hz.

(b) Check for proper readout (within specified tolerance) with each of the following input voltages applied: 9 volts, 90 volts and 125 volts.

2.16 Kohms Check

(a) Select Kohms.

(b) Check for proper readout (within specified tolerance) with each of the following resistances connected across the DMM input: 1K, 10K, 100K, 1 Meg, and 10 Megohm.

NOTE

If the DMM has been stored for a prolonged period (5 or 6 months) without use, it is recommended that it be operated with a variable transformer, such as a Variac, at one-half line voltage for about two hours before gradually applying full power. This is done to "reform" the electrolytic capacitors in the amplifier and reduce the chance of capacitor failure.

SECTION 3
OPERATION

3.1 CONTROLS

3.2 DIGITIZING AND DISPLAY MODULE

3.3. OFF-ON-HOLD SWITCH. This dual-purpose switch applies power to the instrument and allows the selection of HOLD.

(a) OFF - all power is removed from the instrument.

(b) ON - the instrument is operating and taking readings at four per second.

(c) HOLD - "freezes" the last reading of the instrument until it is switched back to the ON position.

3.4. CALIBRATE ADJUSTMENT. This is a flat-blade screwdriver-adjusted potentiometer used in conjunction with the accessory module to calibrate this DMM. Instructions for this operation are described in paragraph 3.7.

3.5. ACCESSORY MODULE (Figure 3.1)

3.6. All controls on the Model 230 Module, with the exception of the screwdriver-adjusted ZERO control, are pushbutton switches, located on the front panel.

3.7 CALIBRATE SWITCH. This is a momentary switch that causes a test reading to appear in the DMM display readout as long as the switch is depressed. The DMM is calibrated by selecting DC and adjusting the calibration potentiometer on the DMM for a reading of -1.0000 (decimal shown for 1V range.)

3.8 AC SELECT. This switch selects the measurement of AC voltages from 50 to 100 kHz on the 1, 10, 100 and 1000 volt ranges.

3.9 KOHMS SELECT. This switch selects the measurement of resistance with full scale ranges of 1K, 10K, 100K, 1 Meg and 10 Megohms.

3.10 DC SELECT. This switch selects DC measurements with full scale ranges from .1 volt to 1000 volts. The three function select switches are interlocked to allow the selection of only one function at a time.

3.11. RANGE CONTROL. The range control consists of six interlocking pushbutton switches: .1, 1, 10, 100, 1000 and AUTO.

(a) Manual ranges. Ranges are selected by depressing the appropriate switch. The switches are interlocked so that as one range switch is depressed, the previously selected range switch is returned to open position.

(b) Auto range. This mode allows the DVM to select the range that provides the highest accuracy for the signal being measured. This switch is interlocked with the five range switches.

3.12 ZERO ADJUST. To zero the DMM, short the two input leads together, select DC and auto-range. Adjust the ZERO potentiometer for a DMM readout display of 00000.

3.13 OPERATION

3.14 GENERAL. The instrument has been designed for the simplest possible level of operation.

Once the instrument has been connected to the power line and to the signal source in accordance with the instructions, the operator can make all the required measurements by setting the front panel controls to the indicated positions.

> CAUTION
>
> Voltage applied between ground and the low-input terminal must not exceed 250 volts.

3.15 DC MEASUREMENTS. Attach the high side of the signal source to the red signal input terminal, the low side to the white signal input terminal.

3.16 AC MEASUREMENTS. Attach the high side of the signal source to the red signal input terminal, the low side to the white input terminal. Normally, the ground terminal (which is at the DMM Chassis Ground) is jumpered to the white signal input terminal.

3.17 OHMS MEASUREMENT. Connect the resistance to be measured between the red and white signal input terminals. The ground terminal may be connected to the white input terminal if desired.

Figure 3.1 - Model 230 Control Panel

SECTION 4

THEORY OF OPERATION

4.1 INTRODUCTION

4.2. Theory of operation of the 4400 Series DMM is described in two parts. First, the Accessory (signal conditioning) Module is described; then the Digitizing and Display Module. The purpose of the Accessory Module is to supply a 10-volt analog voltage for measurement in the Digitizing and Display Module.

4.3. Diagrams used in this section are intended to supplement the complete schematics included in Section 6. All logic circuits are defined at the end of this section.

4.4 ACCESSORY MODULE

4.5 The Accessory Module 230 provides a 10-volt full-scale (12 volts with overrange) analog signal for measurement by the Digitizing and Display Module. The Isolator, range logic circuits and active filter are located on the isolator board. The AC and Ohms Converters are located on an assembly board which is mounted directly above the isolator board in the 230 module.

4.6 ISOLATOR (Figure 4.1)

4.7 The Isolator is a floating input potentiometric amplifier capable of operating at very low signal levels. Its output is a 10-volt full scale analog voltage (12 volts, in overrange) that is applied to the Digitizing module for measurement. The amplifier operates at a gain of one, ten, or a gain of one hundred, depending on the range (see Table 4.1). The gain is switched by relays K2 and K3 that control a resistor divider into the feedback circuit when energized.

4.8 The input to the Isolator is applied through a ranging network that divides the input by 1 or by

Table 4.1 Range Logic

Range	Logic	F/S Isolator Input	Isolator Gain	Relay Position		
				K1	K2	K3
0.1	$\overline{R1}\ \overline{R2}\ \overline{R3}$	.1V	100	Open	Open	Open
1	$R1\ \overline{R2}\ \overline{R3}$	1V	10	Open	Open	Closed
10	$\overline{R1}\ R2\ \overline{R3}$	10V	1	Open	Closed	Closed
100	$R1\ R2\ \overline{R3}$	1V	10	Closed	Open	Closed
1000	$\overline{R1}\ \overline{R2}\ R3$	10V	1	Closed	Closed	Closed
10000	$R1\ \overline{R2}\ R3$	1V	10	Closed	Open	Closed

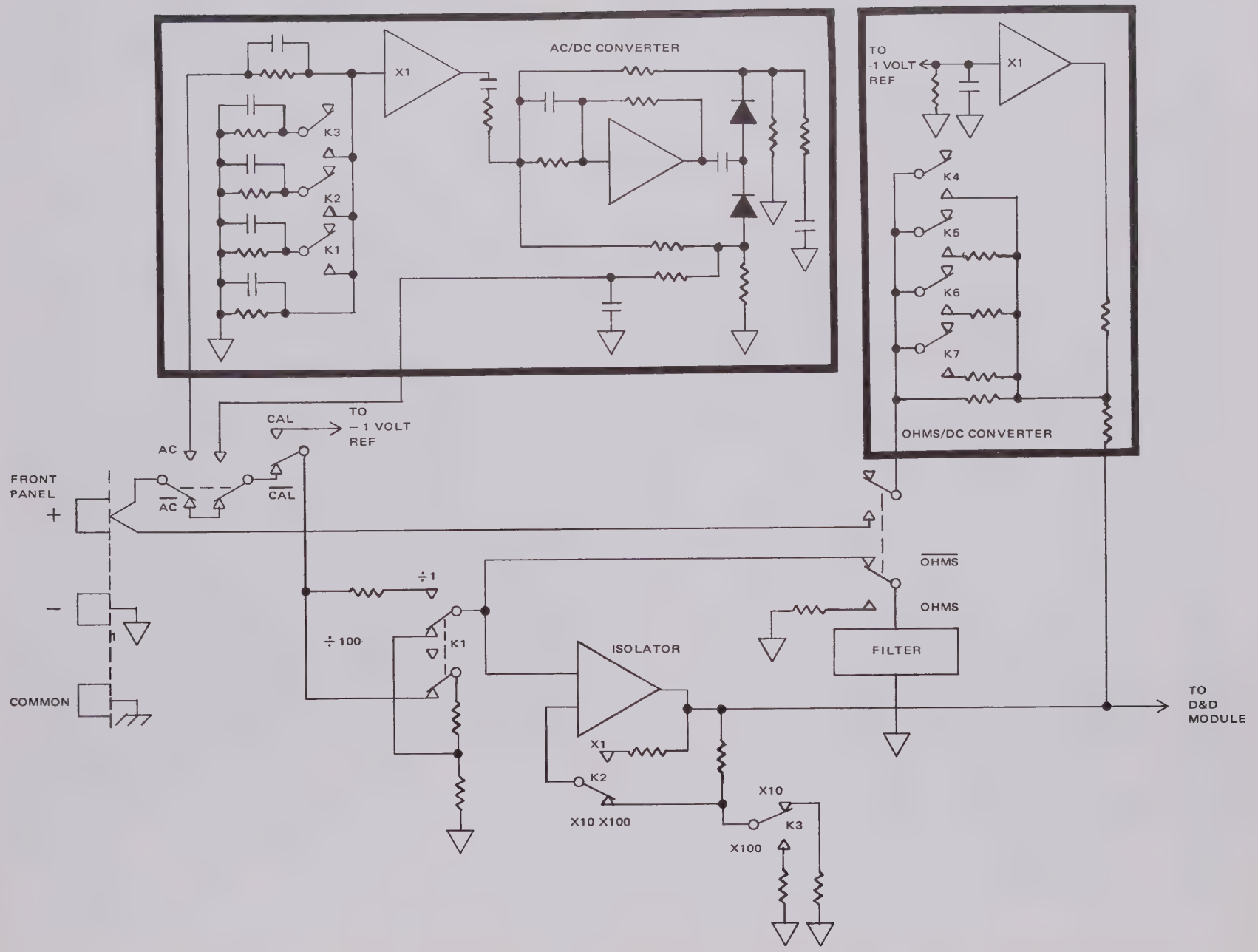


Figure 4.1. Simplified Diagram - Accessory Module

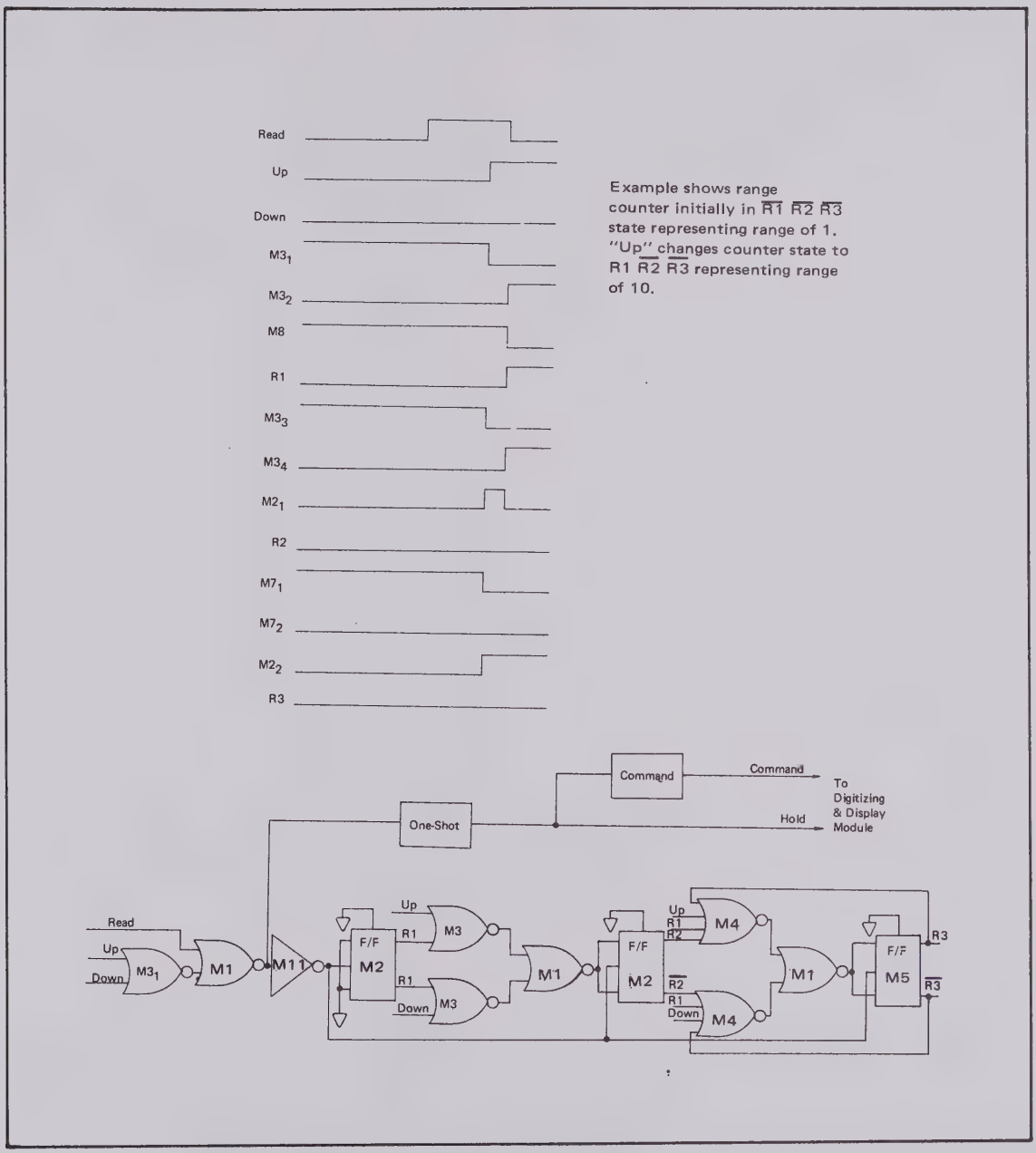


Figure 4.2. Range Control

100, depending on the state of relay K1. This relay and relays K2 and K3 are operated by the range control signals R1, R2, R3 and their complements. Operation of the relays is such that the voltage divider at the input and Isolator gain combine to deliver 10 volts full scale in all measurement modes.

4.9 AC CONVERTER

4.10 With AC selected, the input is routed through the AC Converter before entering the Isolator (figure 4.1). AC ranging is accomplished by a voltage divider network. One RC circuit provides a permanent impedance to reference common for the one-volt range. Relays K1, K2 and K3 add additional impedance to common for the 10, 100, and 2000-volt ranges.

4.11 The scaled input is applied to a unity-gain amplifier that provides isolation and also drives a shield guarding the range relays.

4.12 Rectification takes place in a unity-gain amplifier having polarity-sensitive feedback paths. A half-wave output is taken from the negative feedback leg and applied to the Isolator. In AC mode, the Isolator feedback/voltage divider combination is set to a gain of ten.

4.13 OHMS CONVERTER

4.14 With ohms selected, the instrument remains in the DC configuration and a precise current, produced by the ohms converter in conjunction with the output of the isolator, is supplied to the positive input terminal. A resistance placed across the DMM input terminals is measured by measuring the voltage I-R drop produced across it. Ranges are selected by changing the amount of current supplied to the positive input terminal of the DMM.

4.15 In operation, the gain of the isolator is set at X10 and the output of the isolator is combined through a voltage divider with the 1 volt output of the ohms connector amplifier. Current from the voltage divider is fed through the range resistors and the resistor being measured. The output of the isolator, which is the value displayed by the DMM, is equal to:

$$eo = \frac{9\,Rx}{900 + Range}$$

4.16 RANGE CONTROL (Figure 4.2)

4.17. Ranging of the instrument is controlled by a two-stage flip-flop counter driven by control signals from the Digitizing and Display Module. These Control Signals are Up Range, Down Range and Read.

4.18 Up Range is true when the instrument is not on the highest range (1000 or 10,000 in ohms) and the counter is 12000. Down Range is true when the instrument is not on the lowest range (1 or .1 in DC) and the counter is 00999 or less. Read is true during the measurement period (in the Digitizing and Display Module) of 13 ms. The negative-going edge of this signal indicates the end of the measurement.

4.19. The counter counts up or down in response to the Up Range and Down Range control signals. The state of the flip-flops corresponds to the codes and ranges listed in table 1. A manually-selected range "forces" the flip-flops to the proper state by clamping the appropriate counter outputs to common.

4.20. A one-shot circuit provides a timeout (delay) of about 0.5 sec. at the end of a measurement period to allow time for ranging and for settling time of analog circuits. During this period, the HOLD line goes positive. This line is tied to the input of the control logic circuits in the Digitizing

and Display Module where the positive level prevents a new reading from being taken.

4.21. When operating in a selected range, rather than autorange, the HOLD line is permanently strapped to common by the range switch and new readings are allowed during a range changing attempt.

4.22 At the end of the Timeout, a Read command consisting of a positive pulse is sent to the control logic circuits to command a new reading.

4.23 ACTIVE FILTER

4.24 The filter (figure 4.3) is a three-pole broadband active filter used in both AC and DC measurements. The circuit, a modified gaussian filter, provides normal mode noise rejection of 60 dB at 60 Hz increasing 18 dB per octave to 80 dB.

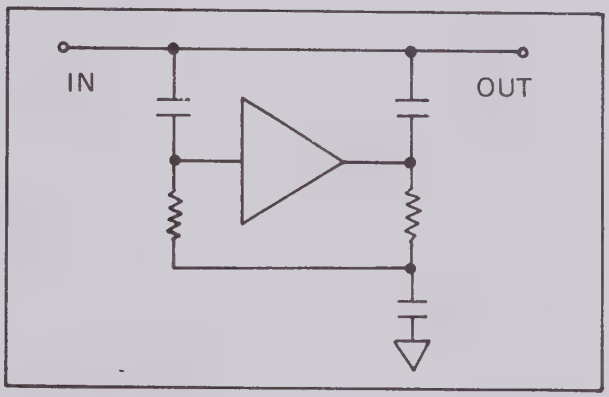


Figure 4.3. Active Filter

The DC signal from the accessory module (a) is applied to the Auto Polarity and Null Detector. This circuitry draws a precise one milliamp of current per input volt from the Null Detector summing node, regardless of the polarity of the input signal. Supplying current to the summing node is an internally referenced integrator, or ramp, which generates a positive, linearly-increasing output voltage (b). A resistor is connected from the output of the ramp to the summing node to supply the current. At the start of a read cycle, the counter is at zero (the 1mHz clock train (f) is inhibited from the counter input at gate (g) by the output of the Control Logic) and the switch across the integrating capacitor of the ramp is on, causing the output of the ramp to be at zero. When a pulse from the Read Rate logic (c) is received at the control logic, the control logic output (d) enables gate (g) and the ramp generator (b).

As the voltage output of the ramp increases, more and more current is supplied to the summing node of the Null Detector. At the same time, the counter is registering the pulses received through gate (d). At the instant the current supplied to the node by the ramp generator is equal to the current drawn from the node by the input, the Null Detector produces a pulse (e) resetting the control logic. The output of the control logic (d) goes false, stopping the counter and resetting the ramp to zero, BCD-to-decimal converters decode and transmit information from the counter to the readout tubes where the value of the DC input is visually displayed. The polarity sense circuitry monitors the output of the auto polarity amplifier and selects the polarity symbol displayed. In the event the input voltage to the Digitizing and Display portion of the DMM is greater than the instrument is able to read; the DMM follows the prescribed read cycle until the counter reaches 12,000. At this time, the 12,000 sense circuitry bypasses the Null Detector and resets the control logic. The display reads 12,000 and the overload indicator lights.

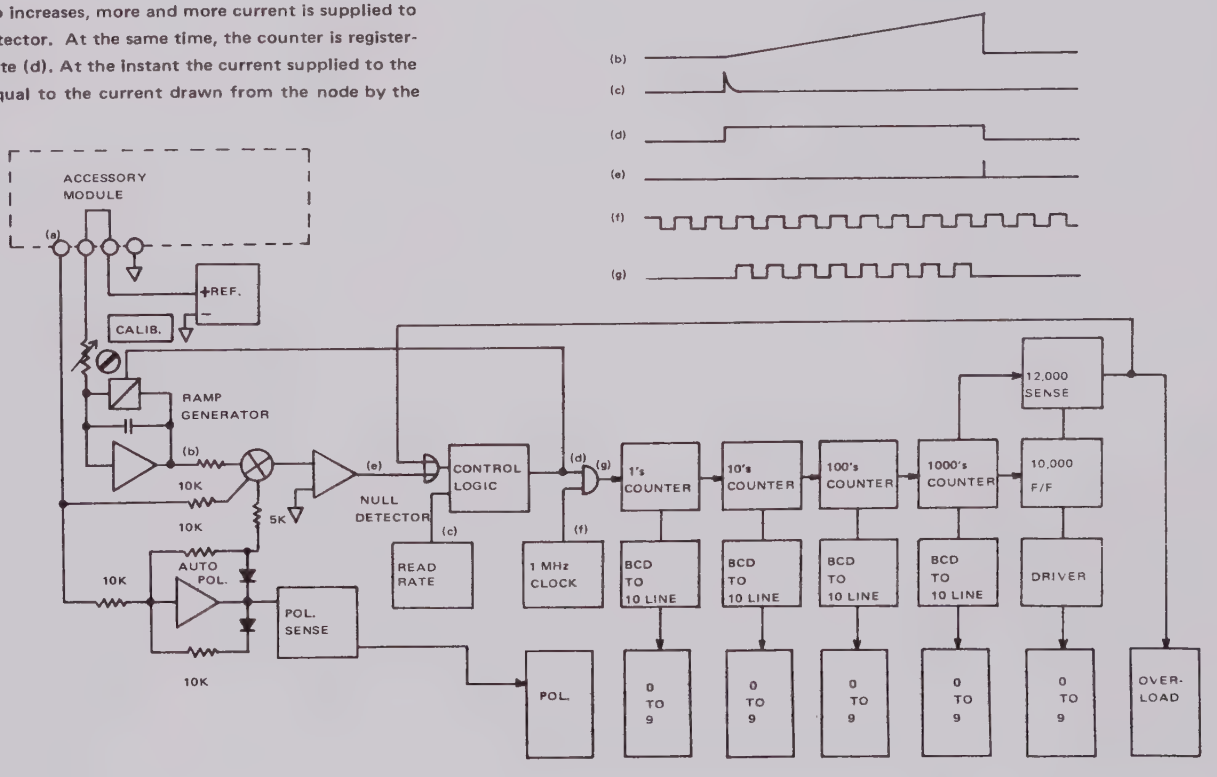


Figure 4.4. Block Diagram - Digitizing and Display Module

4.25 DIGITIZING AND DISPLAY MODULE

4.26 A simplified block diagram of the Digitizing and Display Module is shown in figure 4.4.

4.27 AUTO POLARITY

4.28 The Auto Polarity is a high gain amplifier having two polarity-selected negative feedback paths. The Auto Polarity circuitry eliminates the need for polarity switching by maintaining (in conjunction with the Accessory Module) a negative input to the Null Detector, regardless of the polarity of the input. The output of the amplifier is routed through two diodes, one allowing current to flow during a negative output through one feedback leg, and the other allowing current to flow during a positive output through the other feedback leg (see figure 4.5). The two legs, designated "-" and "+", respectively, provide negative feedback to the input of the amplifier, resulting in a closed-loop gain of minus one. The Auto Polarity amplifier network is used with the Accessory Module output to provide the negative source. The output of the accessory is routed through a 10K resistor to the summing junction of the Null Detector. The negative leg (leg conducting during a negative output of the Auto Polarity amplifier) is connected to the same summing junction through a 5K resistor. When a negative voltage output from the Accessory Module is applied to the Digitizing and Display portion of the DMM, a current is drawn from the summing junction through the 10K resistor. The output of the Auto Polarity is positive, so the "-" leg is non-conducting and has no effect on the summing junction. A positive voltage from the Accessory Module, on the other hand, feeds current into the summing junction through the 10K resistor. At the same time, an amount of current equal to twice the current flowing through the 10K resistor is being drawn from the summing junction through the 5K resistor of the non-conducting '-' leg of the Auto Polarity amplifier. The net sum is a current drain due to the positive input that is equal to the drain produced by an equal amount of voltage of the opposite polarity or negative. Therefore, the summing junction of the Null Detector sees a current drain regardless of the polarity of the input.

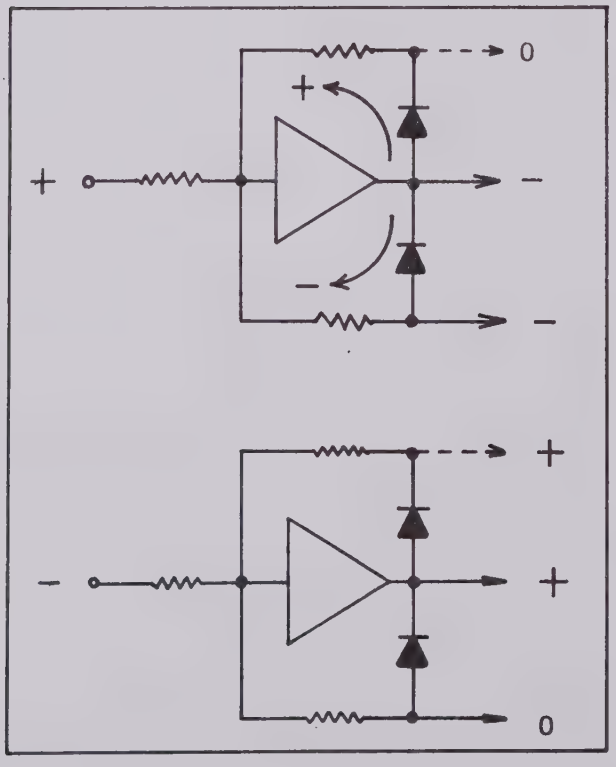


Figure 4.5. Auto Polarity Circuit

4.29 RAMP (Figure 4.6)

4.30 The ramp is an operational amplifier having a capacitive rather than a resistive feedback circuit. The result is an integrator which converts a current input to a continuous, linearly-increasing voltage output. This output, when plotted against time, forms a ramp; thus its name. Since the voltage varies directly with time, any given period of time can be equated with a certain voltage (within the limitations of this amplifier). By providing the ramp (or voltage-to-time converter) with a precise

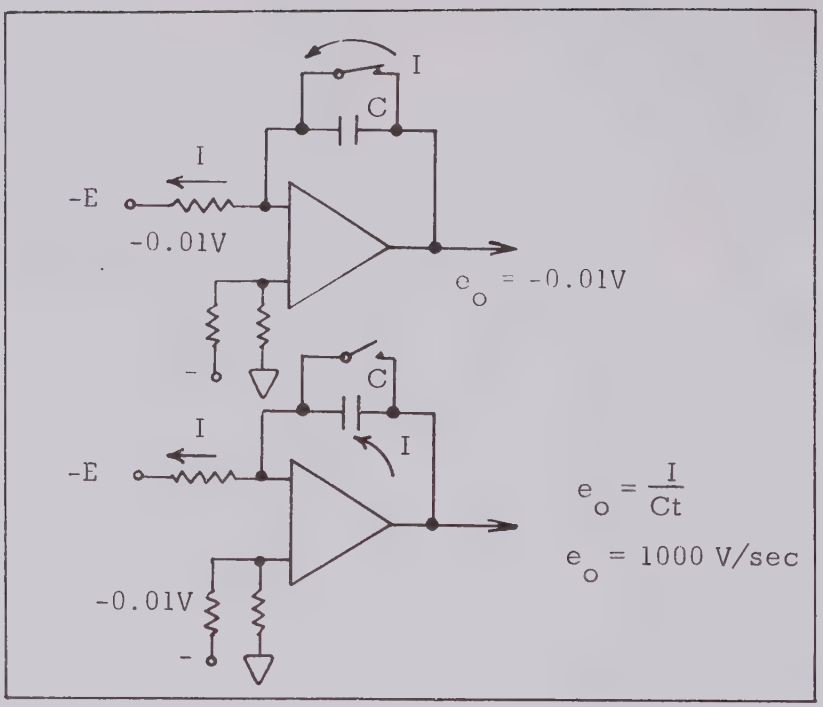


Figure 4.6. Ramp

input current, the ramp becomes a reference by which voltage measurements can be made. Prior to the initiating of a read cycle, a low-leakage switching transistor, shunting the integrating capacitor, is conducting. This causes the output of the ramp amplifier to maintain a voltage level of approximately -10 millivolts determined by a fixed voltage divider. At the start of a read cycle, the switching transistor is turned off, allowing the capacitor to charge and the ramp output voltage goes positive at a rate of one volt per millisecond. The negative bias to the input (voltage divider) allows the ramp time to settle prior to passing through zero volts.

4.31 INTERNAL REFERENCE (Figure 4.7)

4.32 The internal reference voltage is generated by a highly stable zener diode and, in conjunction with a resistor, draws a precise current from the ramp. The zener is supplied with a specific current by the four-stage reference amplifier which allows the reference to operate at its zero temperature coefficient. Because loading on the reference zener is constant, the reference voltage is taken directly from across the zener terminals, without requiring further buffering.

4.33 NULL DETECTOR (Figure 4.8)

4.34 The Null Detector is an open loop high-gain amplifier that determines when the ramp output and accessory module output are of equal potential.

4.35 Prior to a Read Command, the output of the Accessory Module, in conjunction with the output of the Auto Polarity, produces a current drain from the summing node at the input to the Null Detector. Another current drain is produced by a resistor connecting the Null Detector summing node to the output of the ramp (the output, prior to the read command, is at -10 millivolts). Upon receipt of the read cycle, the ramp output goes positive and supplies current to the summing node. When the algebraic sum of the currents equals zero, the Null Detector signals the ramp to reset and the counter to stop.

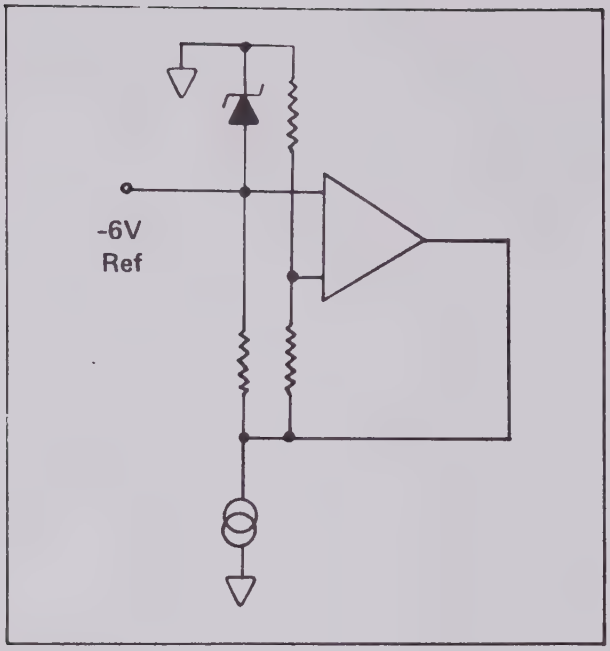


Figure 4.7. Internal Reference

4.36 BINARY COUNTER (Figure 4.9)

4.37 The counter digitally measures the time required for the ramp to reach the potential of the Accessory Module output. Prior to a read command, the counter is at zero and $\overline{Q}$ of the precount flip-flop is true, inhibiting the 10's decade. When the DMM is commanded to read, clock pulses are fed into the 1's decade, causing the decade to count. On the tenth count, a pulse appears at the input of the NOR gate feeding the 10's decade, but is blocked by the positive bias of $\overline{Q}$ of the precount flip-flop. At the same time, the precount flip-flop is reset and the counter is again at all zeros. The counter begins counting for a second time, but without the 10's decade being inhibited. The counter continues to count until stopped by the Null Detector or the overload circuitry. The first ten counts of the binary counter allow for the settling time of the ramp generator. The DMM is calibrated so that the ramp output crosses the zero volts axis at precisely the same instant that the binary counter begins its second count.

4.38 CONTROL LOGIC

4.39 The control logic covers the four logic circuits which program the various functions of the DMM.

4.40 Rate Control. This circuitry determines the number of readings taken by the DMM for a given time period (figure 4.10). Under normal reading conditions, the rate control allows the DMM to take four readings per second. During a range change, a timeout is generated and inhibits further readings until the change is complete. At completion, a read command pulse is generated, causing the DMM to take a new reading. Timing for the read rate circuit is controlled by a unijunction oscillator that produces a six-millisecond pulse every 250 milliseconds. The pulse is applied to two one-shot generators. One-shot (b) produces a 20-microsecond preset pulse. The preset pulse is used to preset the binary counter flip-flops and the precount flip-flop. The preset is also used by the range logic and a portion of the control logic. One-shot (a) produces a 13-millisecond read pulse. The leading edge of the read pulse enables the setting of the polarity indicator and initiates a range change when required (with auto range selected). The read pulse is inverted and used by the read control logic.

4.41 Read Control. The read control circuit coordinates the rate control output with the clock to properly time the start of the ramp and counter circuits. The circuit is shown in figure 4.11. Two NOR gates (c and d) are interconnected to form an R-S type flip-flop. Prior to a reading, the output of of the flip-flop is held false by the positive output of the rate control circuit. The positive level at the input of the NOR gate (a) inhibits the clock pulse from the set side of the flip-flop. At the start of a read cycle, the rate control output goes false and the 20 microsecond reset pulse goes true, inhibiting the clock from setting the flip-flop true. At the end of the preset pulse, the clock resets the flip-

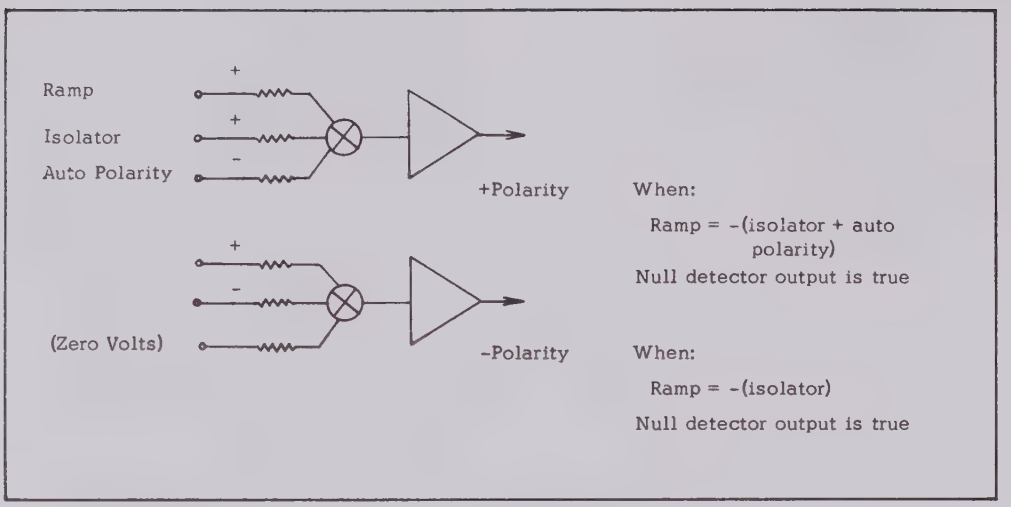


Figure 4.8. Null Detector

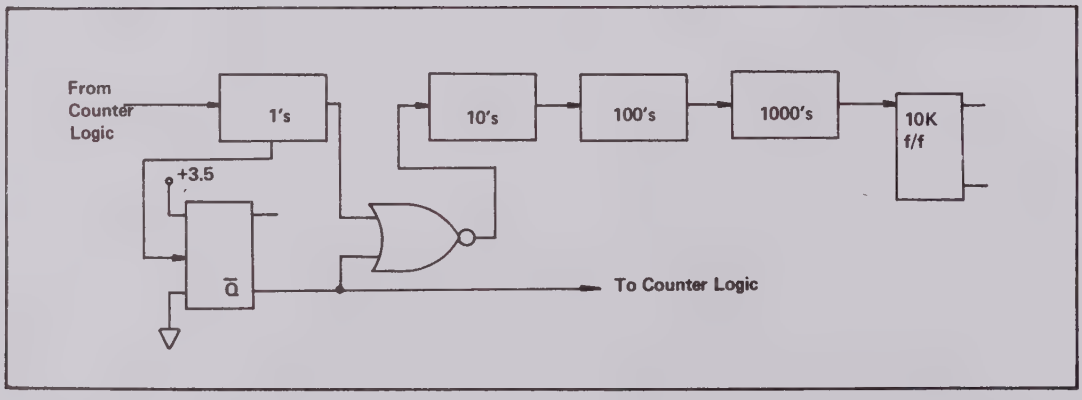


Figure 4.9. Binary Counter

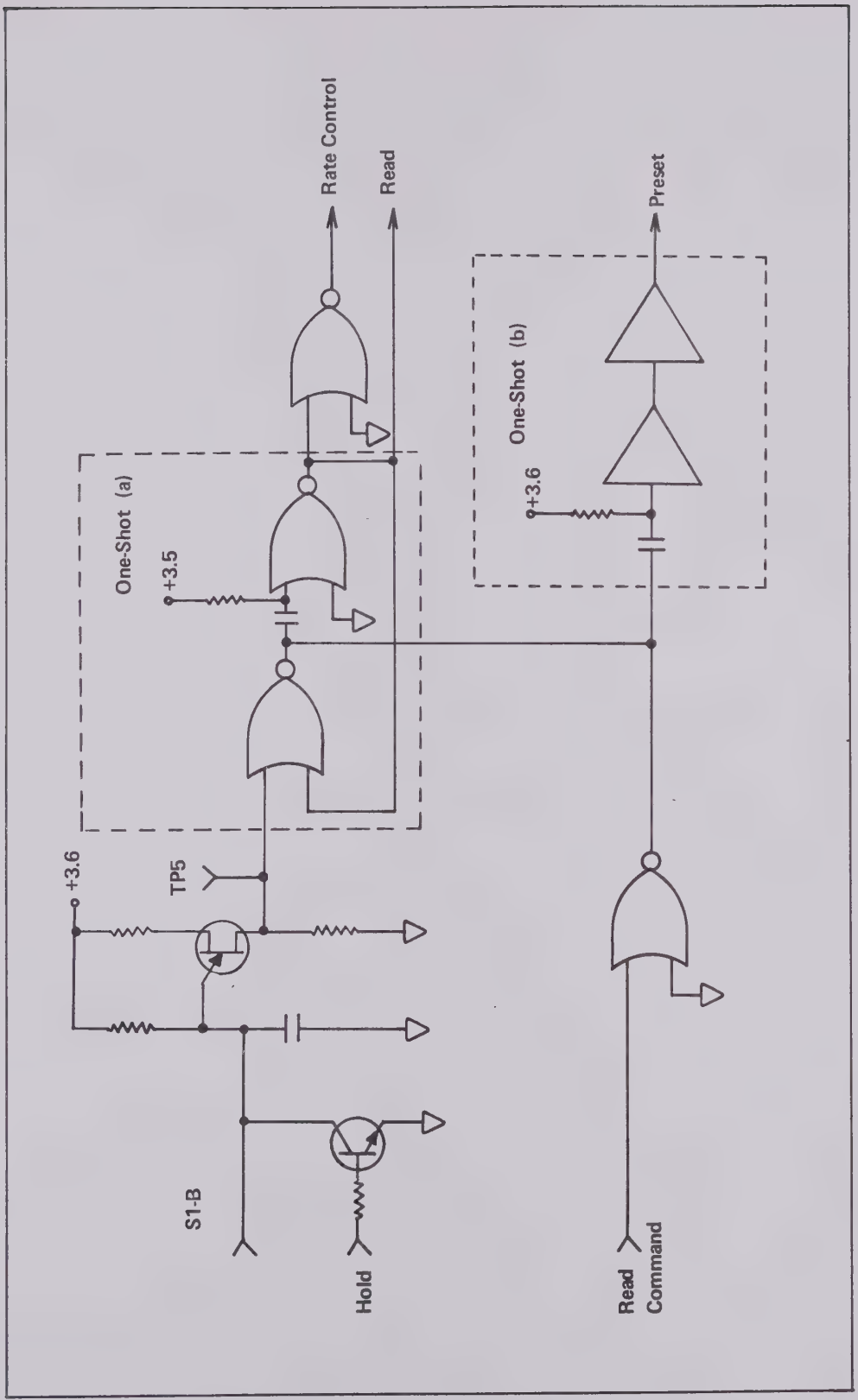


Figure 4.10. Rate Control

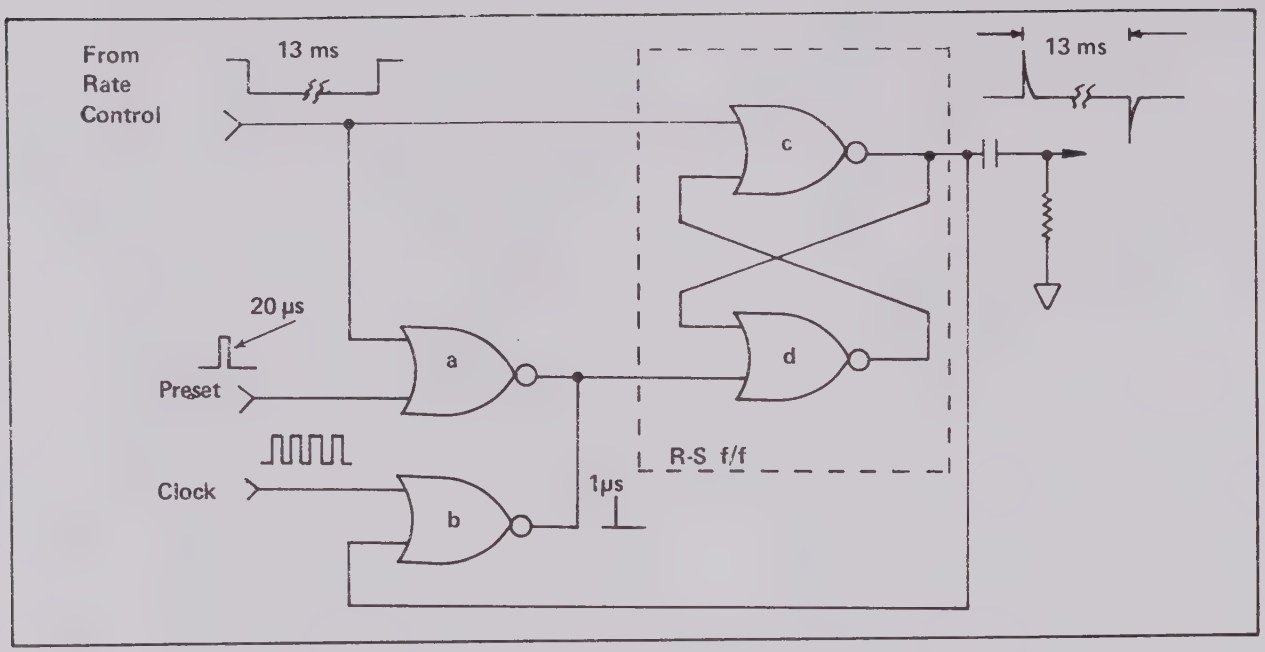


Figure 4.11. Read Control Circuitry

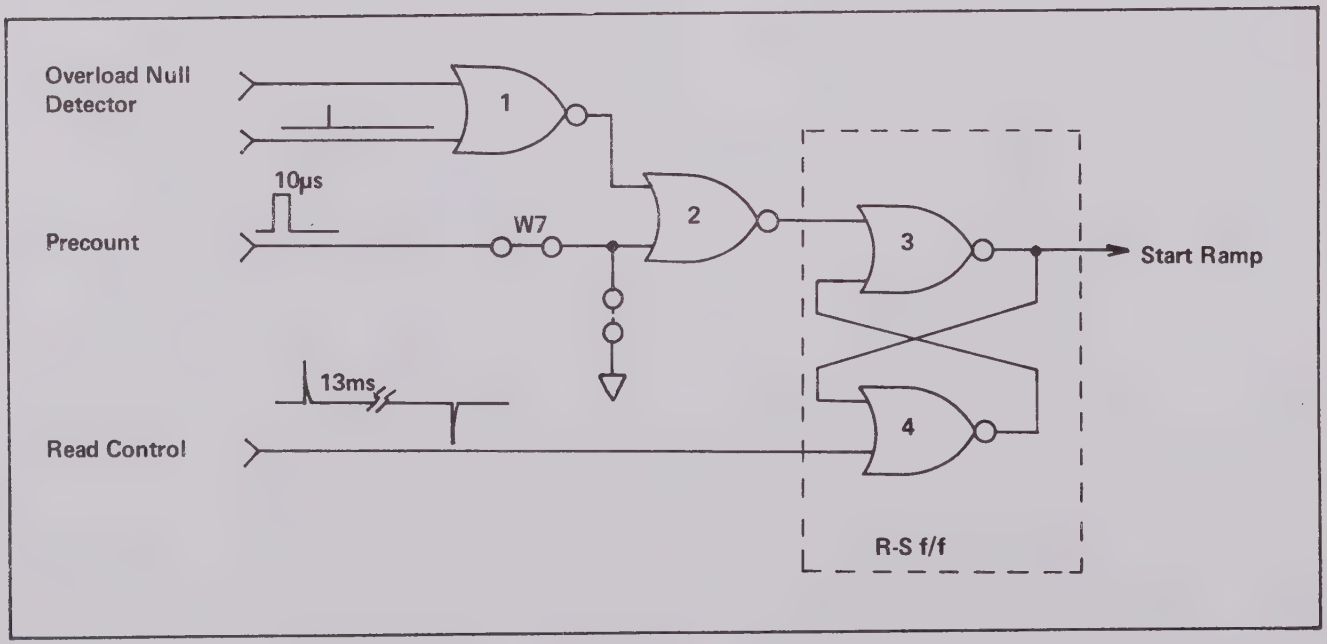


Figure 4.12. Ramp Control

flop. As the flip-flop goes true, the clock pulse is again inhibited, this time by the positive bias at NOR gate (b). The flip-flop remains true for the remainder of the rate control output. The read control flip-flop output is differentiated by an RC network before being applied to the ramp control circuit.

4.42 Ramp Control. The ramp control (figure 4.12) starts and stops the ramp generator. It also controls the blanking circuit and enables the counter control.

4.43 The ramp control flip-flop is set true by the positive-going edge of the read control output. During the precount of the digital counter, the ramp control flip-flop is inhibited from being reset by a precount signal ($\overline{Q}$ of the precount f/f) at the input of NOR gate (2). The flip-flop is then reset on the receipt of a Null Detector output signal or an overload signal at the input of NOR gate (1).

4.44 Counter Control. The counter control circuit (figure 4.13) inhibits the clock train from driving the binary counter until the start ramp goes true.

4.45 BLANKING CIRCUIT

4.46 The blanking circuit lowers the positive supply voltage to the readout tubes causing them to extinguish or blank. Blanking occurs when the start ramp is positive, causing the blanking transistor to conduct.

4.47 RANGE LOGIC (Figure 4.14)

4.48 The range logic generates the information required by the auto range circuitry of the Accessory Module to produce a range change. An up range signal is generated by a logic false appearing at both inputs of NOR gate (a): $\overline{\text{OVERLOAD}}$ and HIGHEST RANGE. $\overline{\text{OVERLOAD}}$ is the $\overline{Q}$ output of the overload flip-flop and is false in an overload condition. HIGHEST RANGE is false when an UP range is possible.

4.49 A down range signal is generated by a logic false appearing at both inputs of NOR gate (b): LOWEST RANGE and the Q output of the DOWN range flip-flop. LOWEST RANGE is false if a DOWN range is possible and Q is set false at the start of a read cycle by the reset pulse. The DOWN

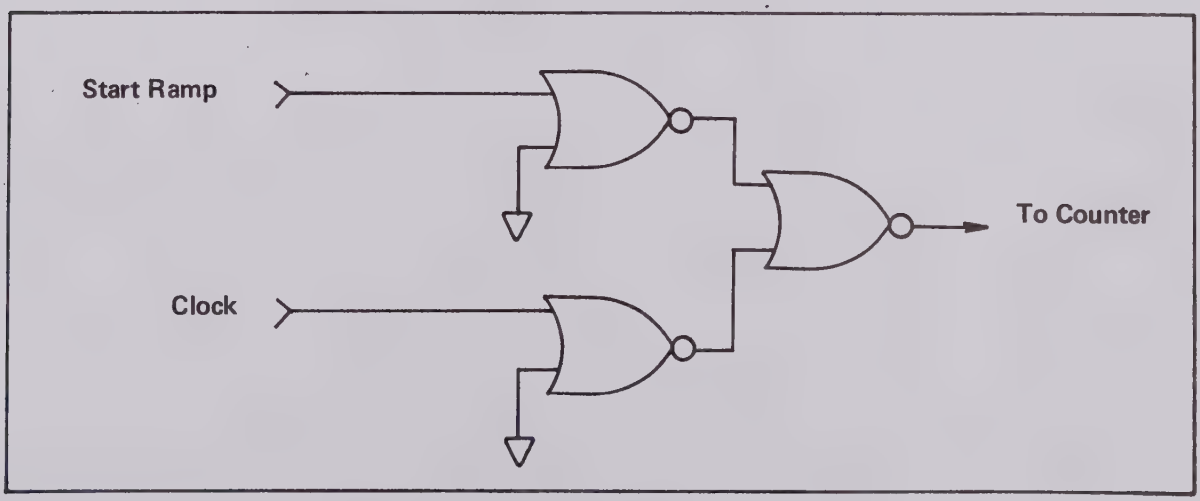


Figure 4.13. Counter Control

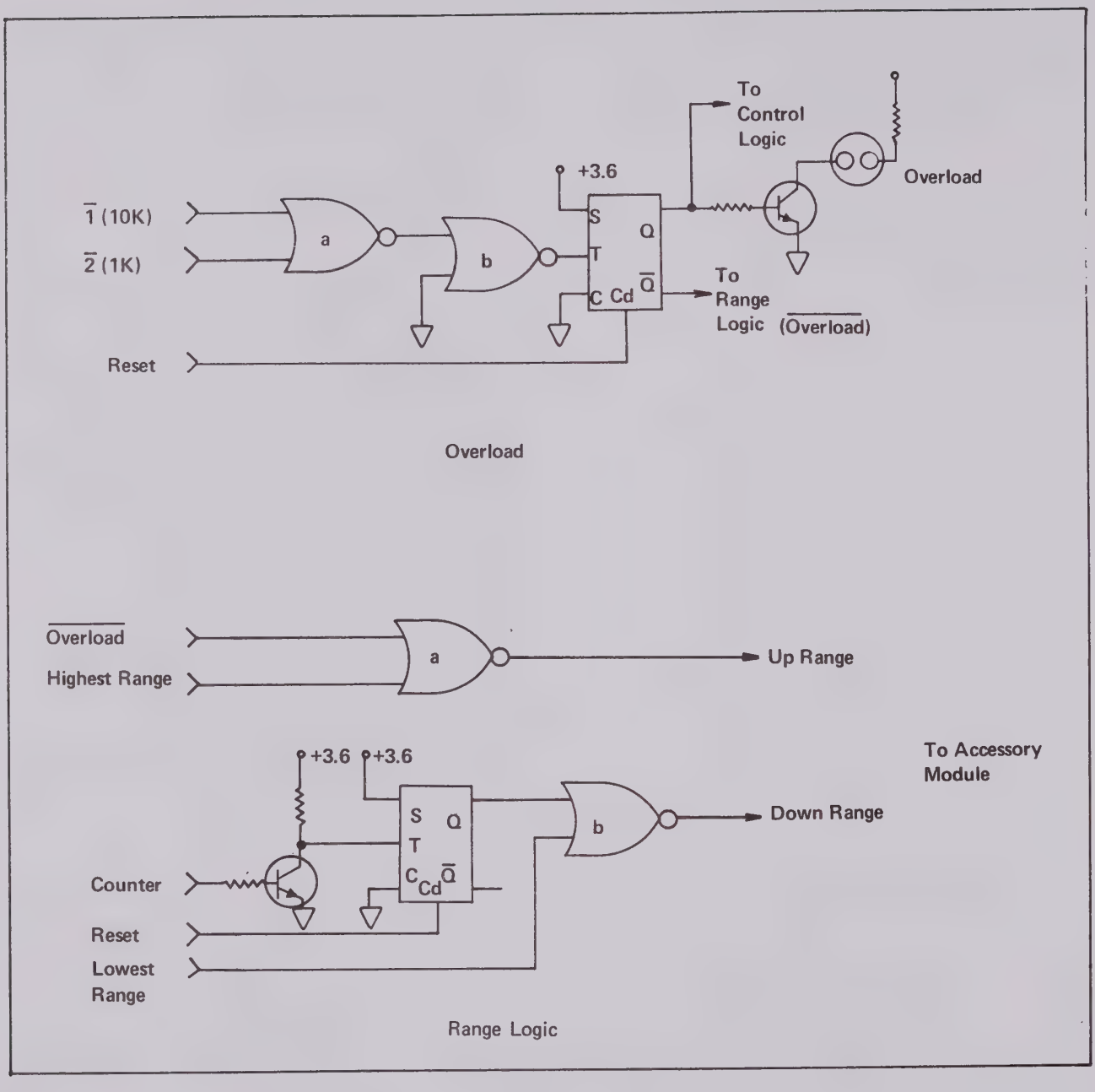


Figure 4.14. Overload and Range Logic

range signal is true until the counter reaches 1000. The flip-flop is set by an inverted signal from the counter. The inverted signal goes true at a count of eight hundred and false again at a count of one thousand, the negative side of the pulse setting Q to logic true.

4.50 Notice that the UP range remains false even in an overload condition when the instrument is in the highest range and the DOWN range remains false during a read cycle when the instrument is in the lowest range.

4.51 OVERLOAD

4.52 The overload circuit detects when the digital counter has reached 12,000 or full scale. A signal is sent to the control logic and the overload indicator lights.

4.53 At the beginning of a reading, the reset pulse sets Q false and $\overline{Q}$ true. The inputs of NOR gate (a) consist of $\overline{2}$ (not 2) of the 1K decade and $\overline{1}$ (not 1) of the 10K flip-flop (actually the zero driver side of the flip-flop). Either one or both of these inputs are true until the counter reaches 12,000. At this time, the output of NOR gate (a) negative-going edge of this pulse causes the overload flip-flop to change state (Q goes true and $\overline{Q}$ goes false). The positive level at Q drives the overload indicator on and signals the control logic to stop the counter and ramp. $\overline{Q}$ is used by the range logic.

4.54 POLARITY SENSE (Figure 4.15)

4.55 The polarity sense circuitry controls the polarity indicator. The Auto Polarity, which automatically compensates for changes in polarity of the input signal, drives the single-staged differential amplifier of the polarity sense circuit. The outputs of the amplifier drive the set (s) and the clear (c) inputs of the J/K flip-flop. The negative going side of the read pulse (following the read cycle) signals the flip-flop to change state if required.

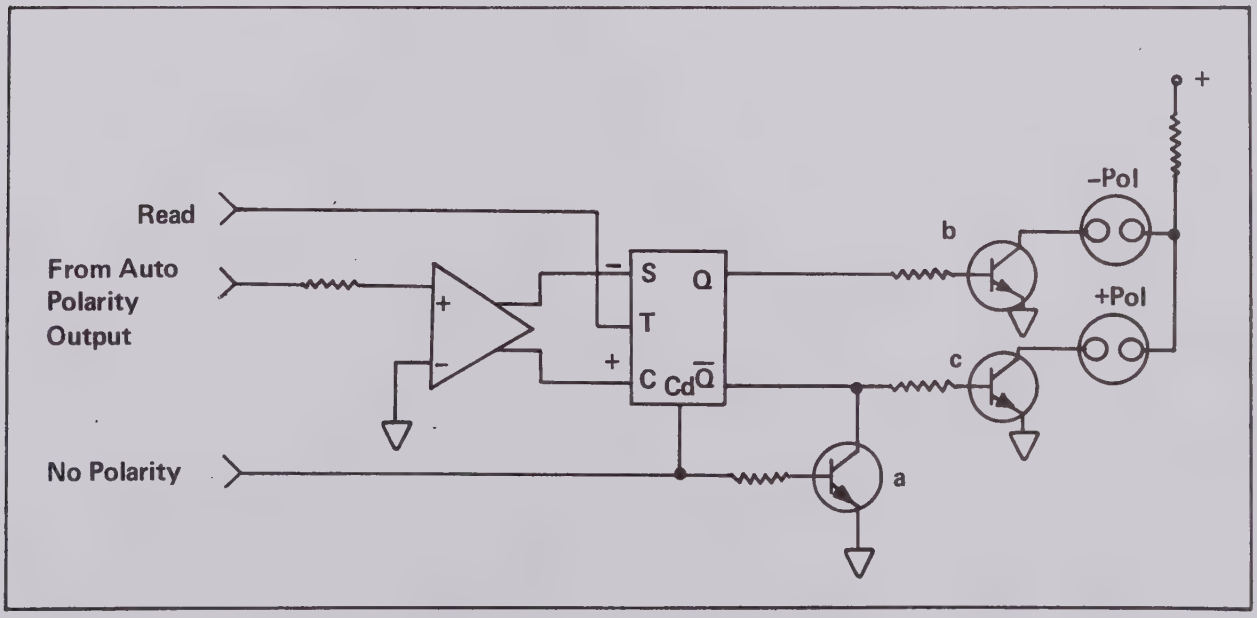


Figure 4.15. Polarity Sense

The flip-flop outputs Q and $\overline{Q}$ control the driver transistors of the minus and plus polarity indicators. The NO POLARITY input is set true when AC is selected. The positive bias at Cd forces Q false and transistor (a) shunts $\overline{Q}$ to false, causing both the minus and plus polarity indicators to remain off.

4.56 CLOCK

4.57 The clock circuit produces a symmetrical 1 MHz stable timing signal for driving the counter circuit.

4.58 The circuit, as shown in figure 4.16, uses two NOR gates interconnected to form a crystal controlled free-running multivibrator. Referring to figure 4.31 the oscillator operates as follows: Assume e1 is false, biasing Q4 off. C is driven negative, turning Q3 off and causing e2 to go true. e2 at true biases Q1 on. C charges positively through R2 until Q3 is biased on (approximately 0.85 volts). At this time, e2 goes false, Q1 is biased off and Q2 is driven off by crystal (x) being driven negative. With both transistors Q1 and Q2 driven off, e1 goes true, biasing Q4 on. R1 charges X until Q2 turns on, setting e1 to false. The operation then repeats itself.

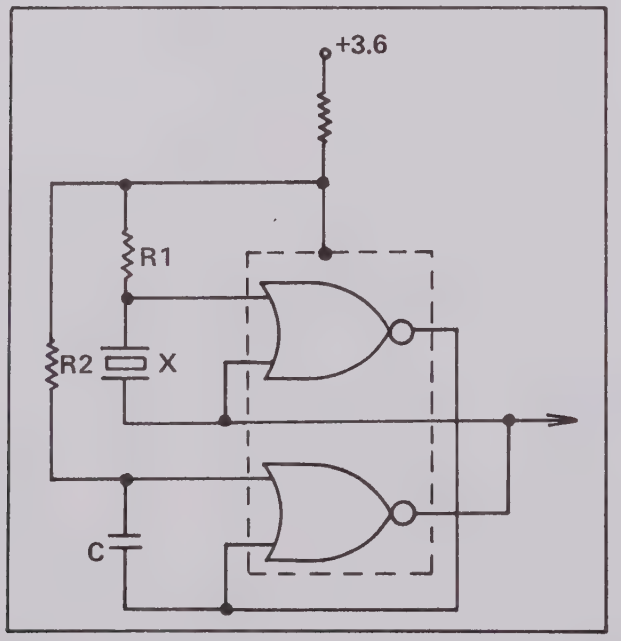


Figure 4.16. Clock

4.59 BCD TO DECIMAL DECODING

4.60 The four J-K flip-flops, A_1, A_2, B_1, and B_2 (figure 4.17) drive the BCD-to-decimal converter and carry the logic weights of 1, 2, 4, and 8, respectively. The four flip-flops and two NOR gates are interconnected to convert ten input pulses into ten separate BCD coded outputs ranging in numerical value from zero to nine.

4.61 At the beginning of a read cycle, the reset pulse is applied to all of the counter flip-flops, setting the outputs false (negative true logic). The logic levels of various points in the counter are shown in the timing diagram of figure 4.17.

4.62 POWER SUPPLY

4.63 3.6 Volt Supply. The +3.6 volt supply is used by all of the micrologic circuitry and in circuits used to directly drive the integrated circuits.

4.64 As shown in figure 4.18, voltage to the supply is provided by a full wave rectified 8 volts from a center-tapped secondary and diodes CR5 and CR6. Reference for the supply is taken from across zener diode CR11. The zener voltage is compared with a fractional part of the output voltage and the error signal used to drive a Darlington coupled emitter follower, Q2 and Q3. The output voltage is taken from the emitter of Q3 and added regulation is provided by capacitor C16.

4.65 High Voltage Supplies. The 300-volt supply provides the anode potential for the nixie readout

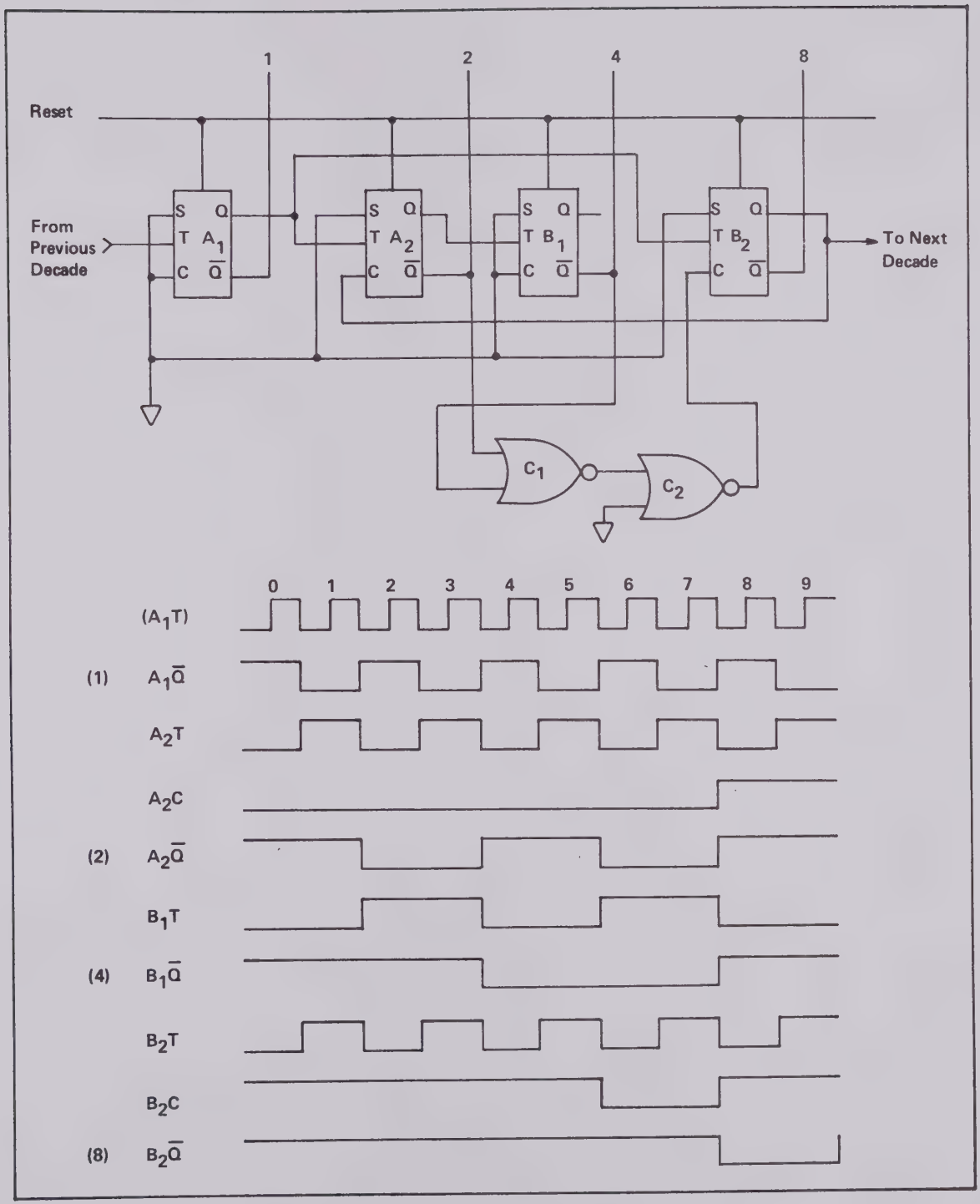


Figure 4-17. BCD - Decimal Conversion

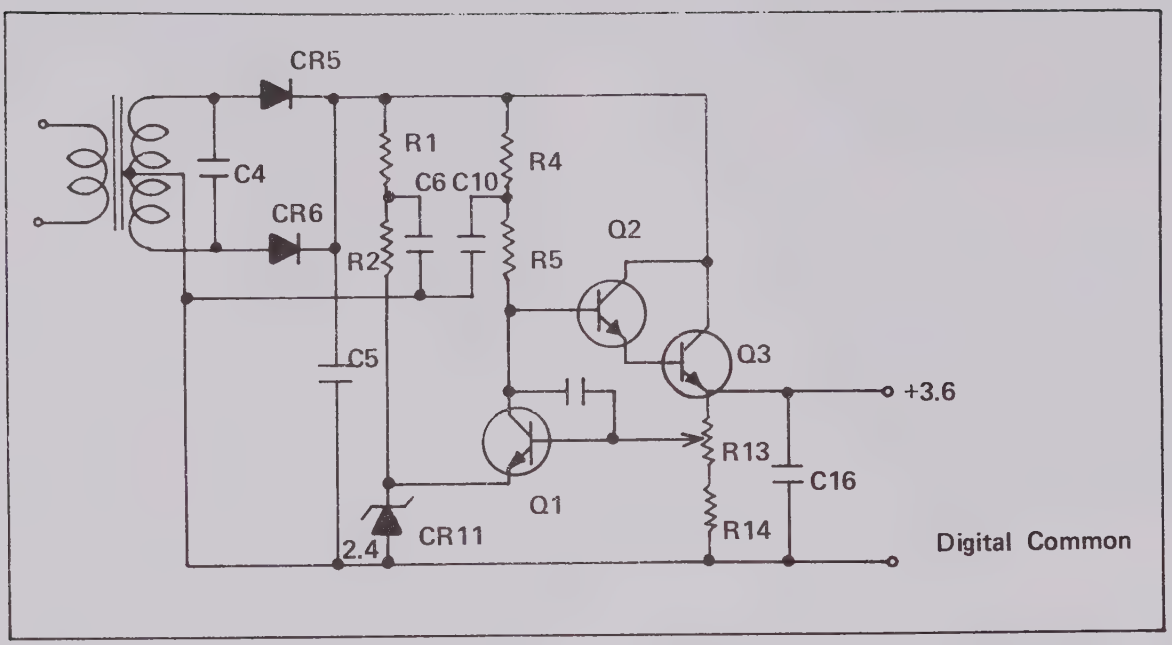


Figure 4.18. 3.6-Volt Supply

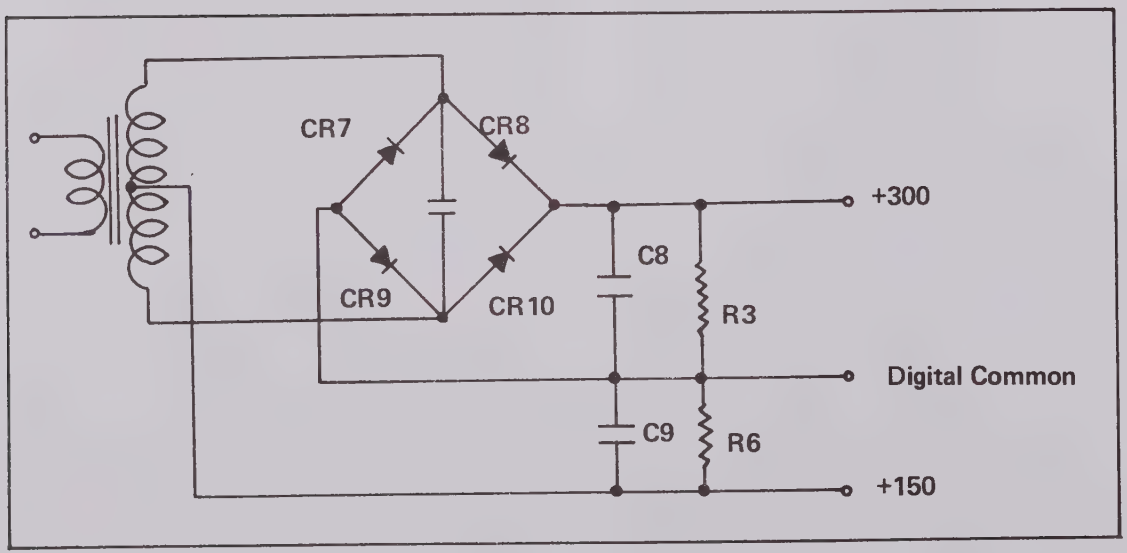


Figure 4.19. High Voltage Supply

tubes. The 150-volt supply provides the required potential for operating the polarity and overload indicators.

4.66 As shown in figure 4.19, the 300-volt output is generated across the bridge rectifier consisting of diodes CR7, CR8, CR9, and CR10. Capacitor C8 provides filtering. The 150-volt output is taken from the center tap of the secondary used for the 300-volt supply. Diodes CR7 and CR9 carry the current of both the 300 and 150-volt supplies. Filtering for the 150-volt output is provided by C9. Commons for all three supplies are tied together.

4.67 28 Volt Supplies. The plus and minus 28 volt supplies are used both in the Accessory Module and in the analog circuits of the Digitizing and Display module.

4.68 Referring to figure 4.20, diodes CR2 and CR4, in conjunction with the secondard winding center tap, form the full-wave rectified +28 volt supply. The -28 volt supply uses the same center tap and diodes CR1 and CR3. Capacitor C2 and C3 are used for filtering.

4.69 18 Volt Supplies. The plus and minus 18 volt supplies are regulated and are used in the same areas of the DMM as the 28 volt supplies.

4.70 Rectified voltage to power the 18 volt supplies is provided by the plus and minus 28 volt supplies. In the +18 volt supply, zener diode CR12 provides a reference of approximately 18.5 volts which is applied to the base of emitter follower Q4. The +18 volts is taken directly from the emitter of Q4 and current from the supply is limited by collector resistor R8. The -18 volt supply uses the same principle as the +18 volt supply. Reference is taken from zener diode CR13 and the -18 volts is taken from the emitter of Q5.

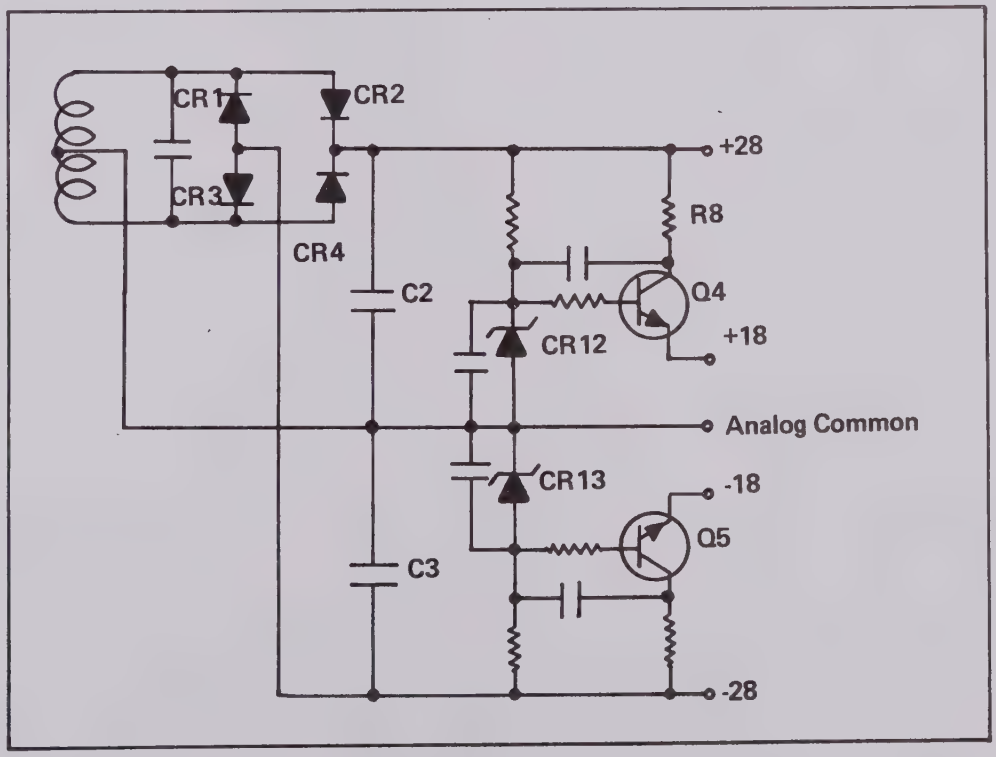


Figure 4.20. 28-Volt Supply

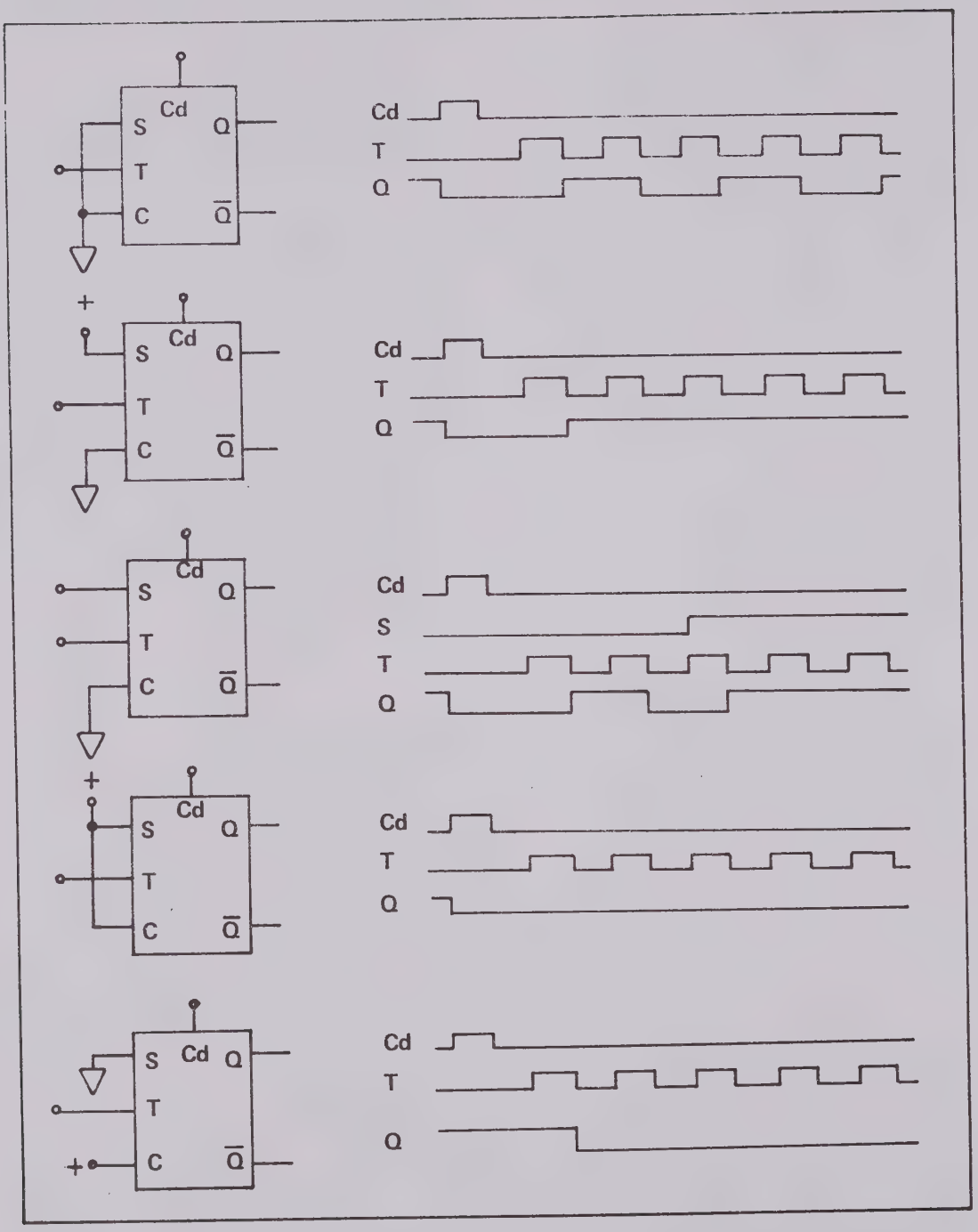


Figure 4.21. Flip-Flop Operating Modes

4.71 INTEGRATED CIRCUIT ELEMENTS

4.72 The following basic integrated circuits are used in the DMM:

MC723P	J-K Flip-flop
MC790P	Dual J-K Flip-flop
CML9960	Decoder Display Driver
MC799P	Dual Buffer
MC724P	Quad Two-input NOR Gate
MC717P	Quad Two-input NOR Gate

4.73 The physical and mechanical characteristics of each of the basic elements are tabulated in figures 4.26 through 4.30 at the end of this section.

4.74 J-K FLIP-FLOP OPERATING MODES

4.75 Shown in figure 4.21 are five common modes of operating the J-K flip-flop in the Series 4400 DMM. Output Q, prior to receipt of the Cd pulse, is determined by the previous state of the flip-flop. Output $\overline{Q}$ is the inverse of Q.

4.76 Figure 4.22 shows the interconnecting of the two NOR gates so as to obtain an R-S flip-flop.

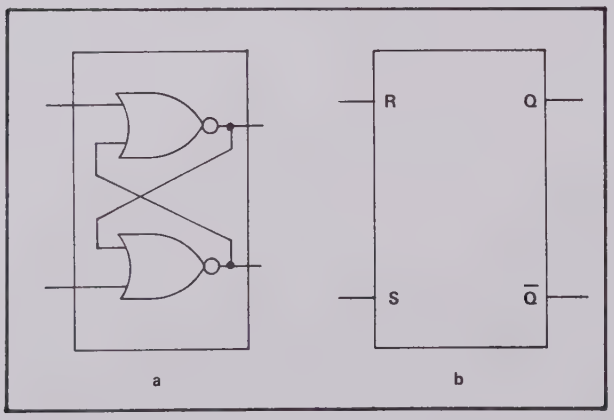


Figure 4.22. Interconnected Nor Gates

4.77 SCHEMATIC IDENTIFICATION OF LOGIC DEVICES

4.78 Reference designators for all devices regardless of type have the letter "M" as a designating letter. This is followed by a number to identify the component uniquely (figure 4.23).

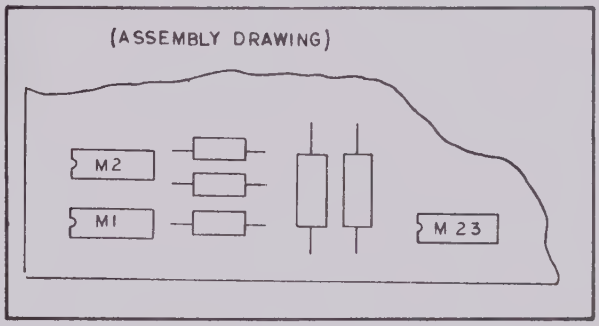


Figure 4.23. Component Identification

4.79 Identification of Logic Function Symbols. Individual logic functions are identified on the schematic by the designator of the logic device in which they appear. In most cases, circuitry for more than one function is encased within the same module. To distinguish between them, an additional letter designator is affixed to that of the device (A, B, C, D, etc.), as required to cover all functions (figure 4.24).

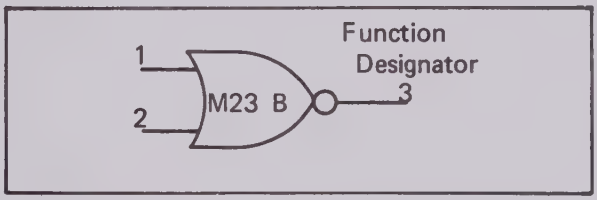


Figure 4.24. Function Designator

4.80 Input-Output Pin Numbers. Module pin numbers are placed outside the function symbols next to the input and output leads.

4.81 Identifying Type of Device. Module (IC element) type is defined on the schematic in note

form. This applies, of course, to the major type used on the schematic. If more than one type of device is used for the same logic function, the least used is defined at the logic symbol.

4.82 Circuit Definition of Logic Devices. A circuit diagram of the logic devices used does not appear on each schematic; rather, schematics in figures 4.26 through 4.30 describe all elements used.

4.83 Restriction on Logic Symbol Usage. On schematics that contain both integrated circuit elements and discrete components, the logic symbols describe only that circuitry which is contained within the devices. In other words, no logic symbols are used to represent a function that is made up of discrete components.

4.84 Standard Symbols. Figure 4.25 shows the standard integrated circuit logic symbols used on Dana drawings.

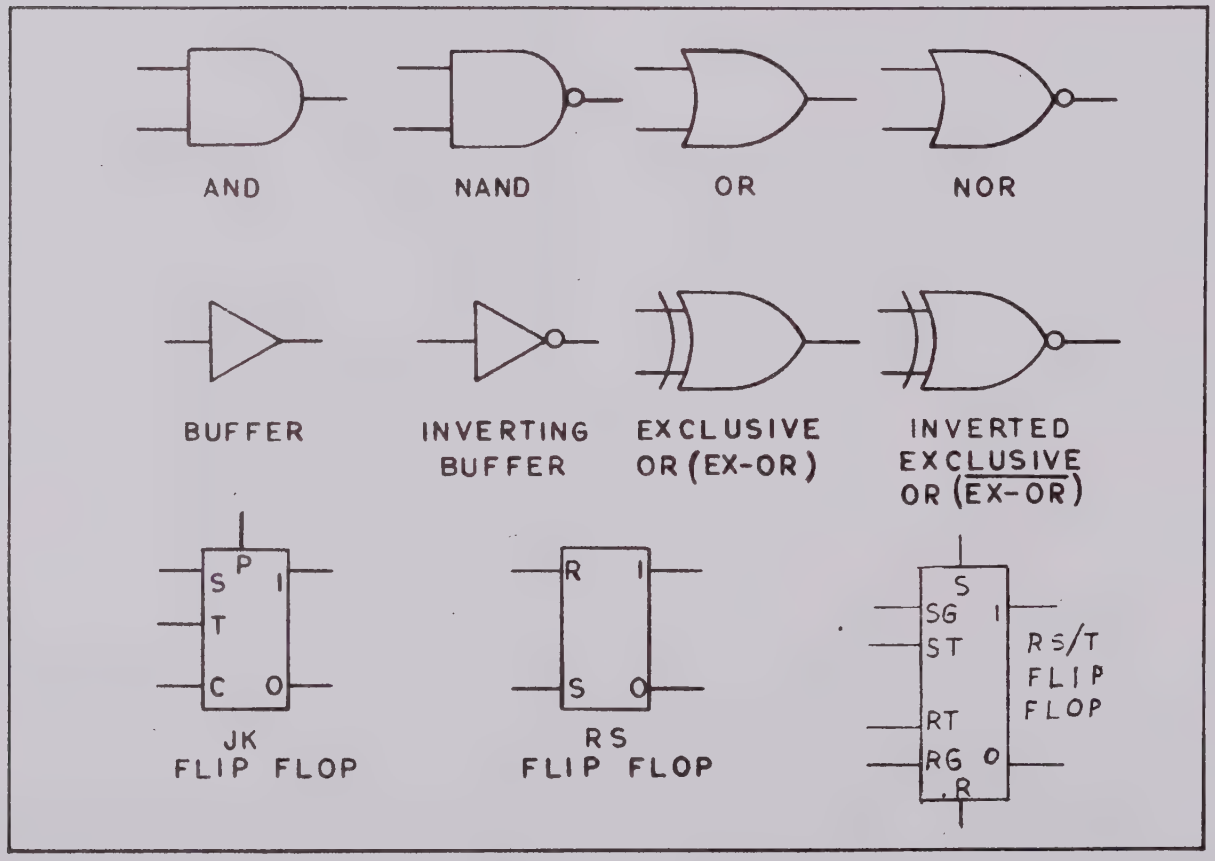
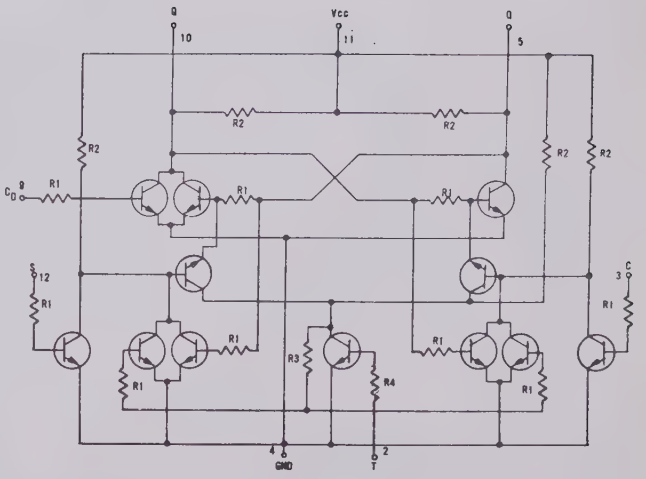


Figure 4.25. Logic Symbols

MC723P J-K Flip-Flop	
R_1	450 Ohms
R_2	640 Ohms
R_3	510 Ohms
R_4	225 Ohms
f_{tog}	4 mHz
V_{off}	+0.46V Max
V_{on}	+0.85V Min
V_{out}	+0.3V Max
Vcc	+3.6V ±10%

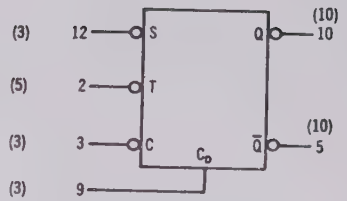
TN (NOTE 2)		TN+1 (NOTE 2)	
S	C	Q	$\overline{Q}$
1	1	QN^3	$\overline{Q}N$
1	0	1	0
0	1	0	1
0	0	$\overline{Q}N$	QN^3

(Note 3)



NOTES:

1. Direct input Cd must be low.
2. The time period prior to the negative transition of the clock pulse is denoted Tn and the time period subsequent to this transition is denoted Tn+1.
3. Qn is the state of the Q output in the time period Tn.
4. Clock Pulse (T) inputs must have a fall time within the range of 10ns to 100ns. Fall time is a straightline function from 1V to ground.



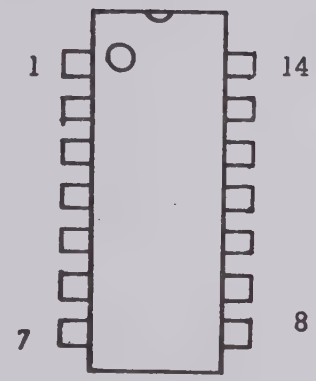
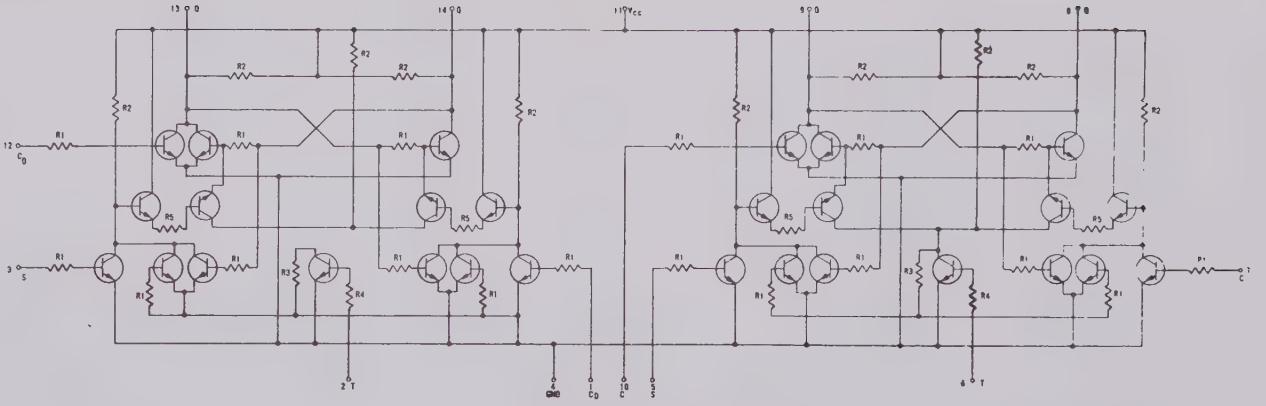


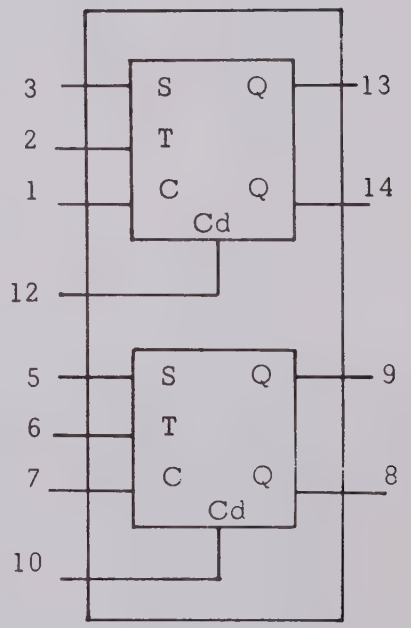
Figure 4.26. J-K Flip-Flop

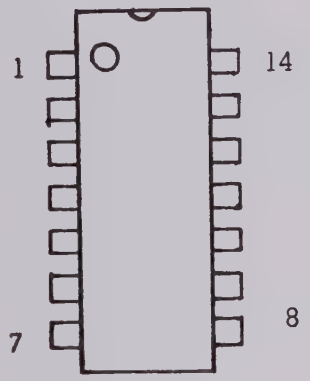
MC 790 P Dual J-K Flip-Flop	
R_1	450 Ohms
R_2	640 Ohms
R_3	510 Ohms
R_4	225 Ohms
R_5	300 Ohms
V_{off}	+0.46V Max
V_{on}	+0.85V Min
V_{out}	+0.3V Max
Vcc	+3.6V ±10%
f_{tog}	4 mHz



TN (NOTE 2)		TN+1 (NOTE 2)	
S	C	Q	$\overline{Q}$
1	1	QN^3	$\overline{Q}N$
1	0	1	0
0	1	0	1
0	0	$\overline{Q}N$	QN^3

(Note 3)



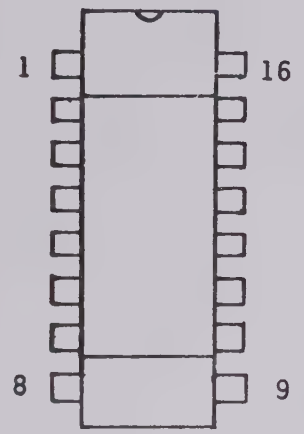


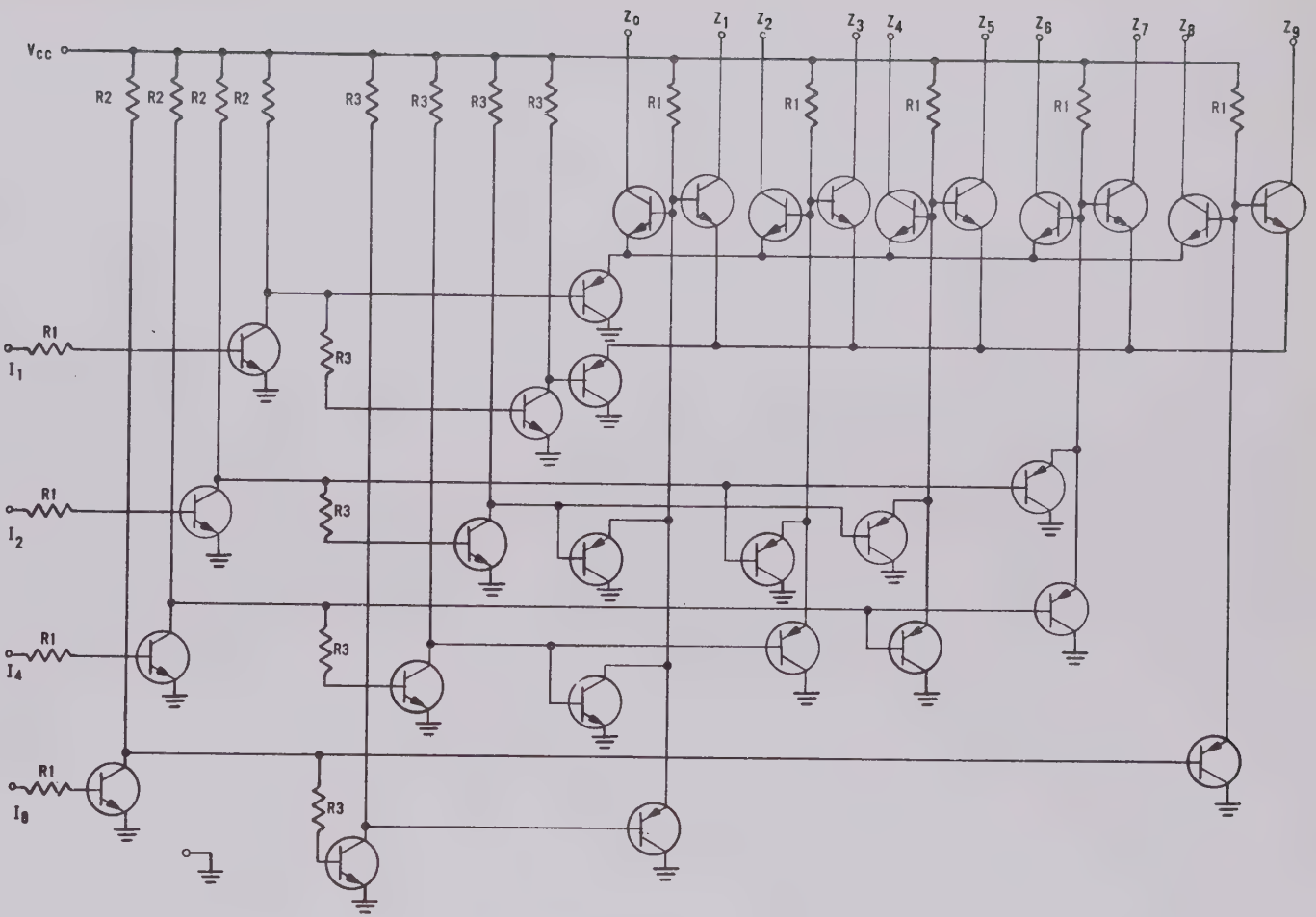
NOTES:

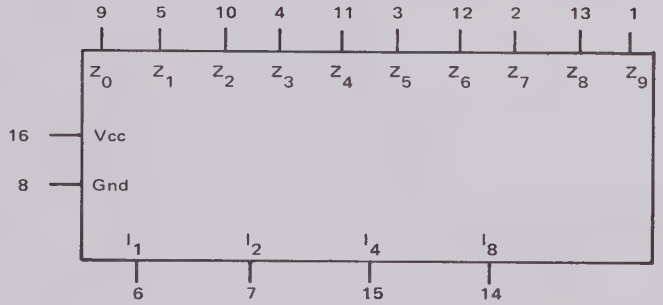
1. Direct input Cd must be low.
2. The time period prior to the negative transition of the clock pulse is denoted Tn and the time period subsequent to this transition is denoted Tn+1.
3. Qn is the state of the Q output in the time period Tn.
4. Clock Pulse (T) inputs must have a fall time within the range of 10ns to 100ns. Fall time is a straightline function from 1V to ground.

Figure 4.27. Dual J-K Flip-Flop

CML 9960 Decoder Display Driver	
R_1	2K
R_2	4K
R_3	5K
V_{off}	+0.4V Max
V_{on}	+1.0V Min
I_{out}	10.0 Ma Max
Vcc	+4.4V ±25%







Input

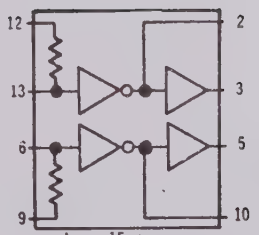
	Digit									
	0	1	2	3	4	5	6	7	8	9
1	1	0	1	0	1	0	1	0	1	0
2	1	1	0	0	1	1	0	0	1	1
4	1	1	1	1	0	0	0	0	1	1
8	1	1	1	1	1	1	1	1	0	0

1 = Vcc

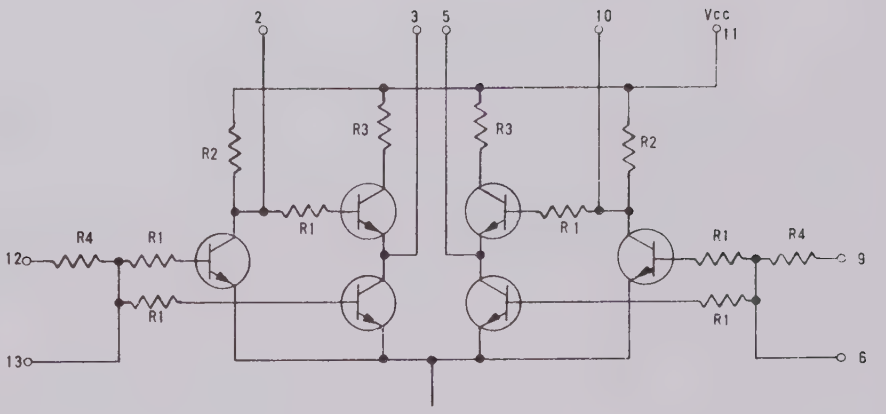
0 = Gnd

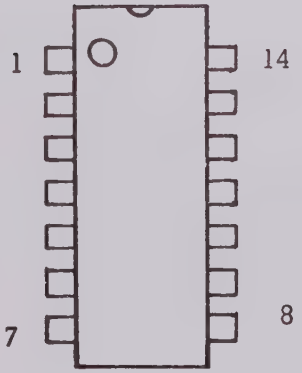
Figure 4.28. Decoder Display

MC 799P Dual Buffer	
R_1	450 Ohms
R_2	640 Ohms
R_3	100 Ohms
R_4	1000 Ohms
V_{off}	+0.46V Max
V_{on}	+0.85V Min
V_{out}	+0.3V Max
Vcc	+3.6V ±10%



Outputs 2 and 3 may not be used simultaneously.
Outputs 5 and 10 may not be used simultaneously.





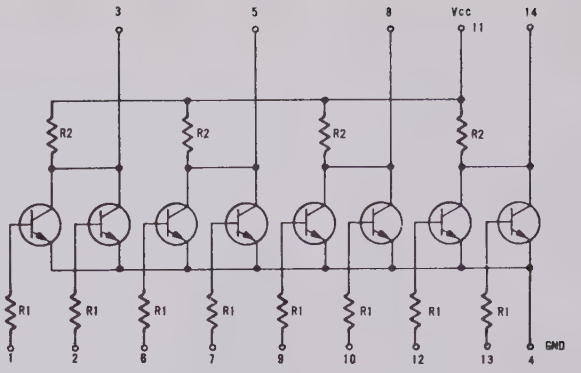
Input					Output			
12	13	6	9		2	3	5	10
0					1			
1					0			
	0					1		
	1					0		
		0					1	
		1					0	
			0					1
			1					0

Figure 4.29. Dual Buffer

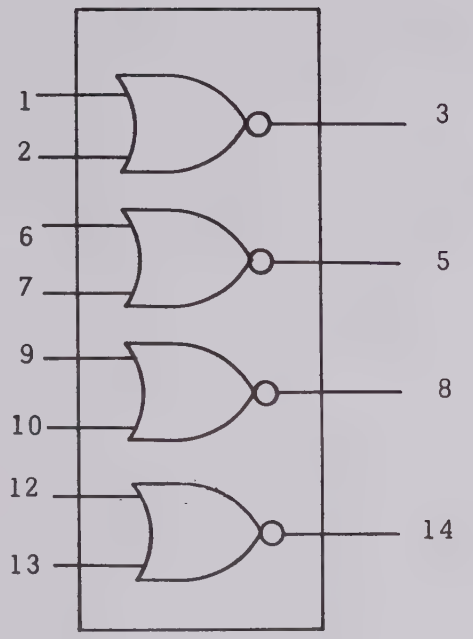
MC 717P
MC 724

QUAD 2-INPUT NOR GATE

	MC717P	MC724P
R_1	1.5K	450 Ohms
R_2	3.6K	640 Ohms
V_{off}	0.46 Max	
V_{on}	0.85 Min	
V_{out}	0.3 Max	
Vcc	3.6 ±10%	



Inputs								Output			
1	2	6	7	9	10	12	13	3	5	8	14
0	0							1			
1	0							0			
0	1							0			
1	1							0			
		0	0						1		
		1	0						0		
		0	1						0		
		1	1						0		
				0	0					1	
				1	0					0	
				0	1					0	
				1	1					0	
						0	0				1
						1	0				0
						0	1				0
						1	1				0



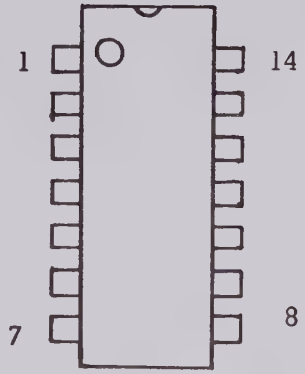


Figure 4.30. Quad Two-Input Nor Gate

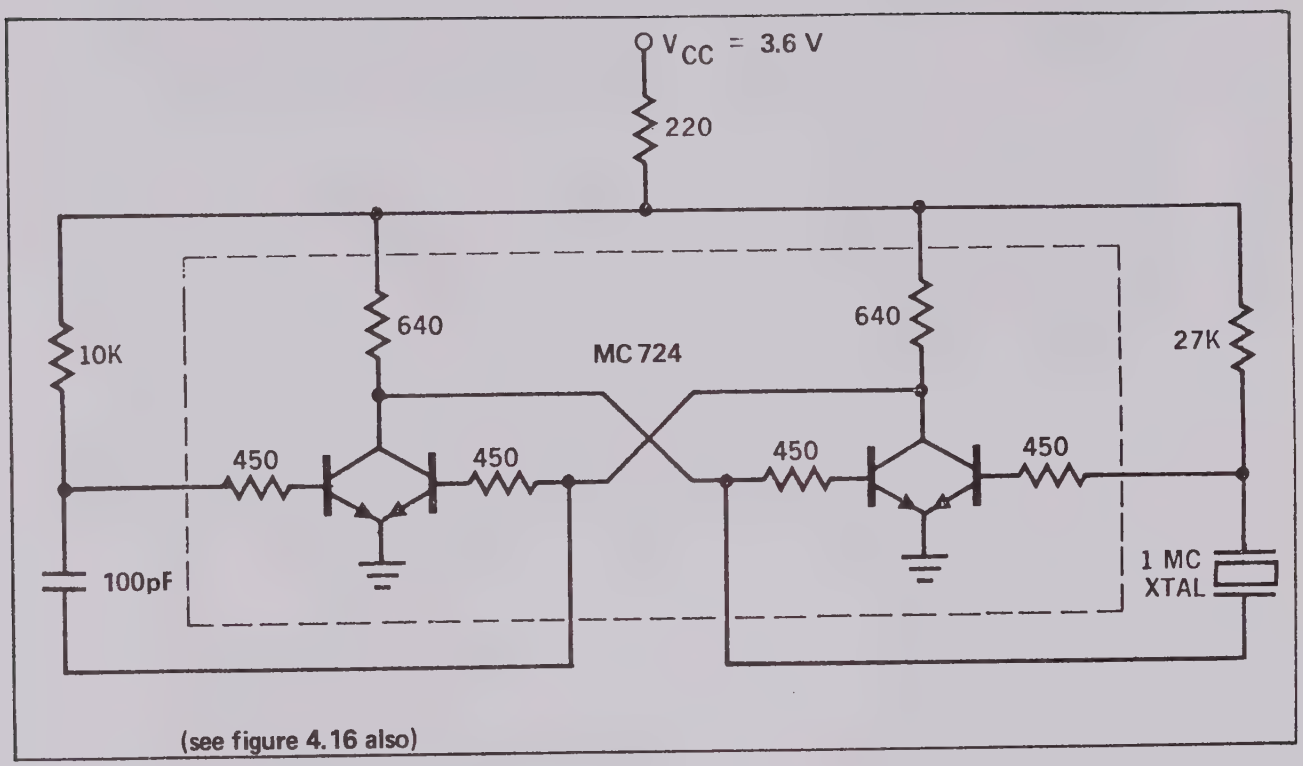


Figure 4.31. MC724 Used as a Crystal Oscillator

SECTION 5

CALIBRATION

5.1 INTRODUCTION

5.2 General. This calibration procedure is designed to keep the Model 4400 Series/230 DMM operating within its specification indefinitely. Any necessary maintenance should be done prior to calibration. Each calibration step in this procedure relies on the accuracy of the preceding step. Care should be taken to make each adjustment in the order that appears in this procedure.

5.3 EQUIPMENT

5.4 General. The following equipment is required for DMM calibration, and is listed in order of use. The specifications listed are the minimum required to make the adjustment.

(a) Precision null detector/microvoltmeter with a minimum of 10 microvolts of resolution. For example, Fluke Model 845AR.

(b) Voltage calibrator variable from 0 to 1000 volts and a resolution better than 100 microvolts (at 1 and 10 volts). For example, Fluke Model 332A.

(c) Laboratory power source (AC) variable from 0 to 500 volts and 50 to 100 kHz with a resolution better than 100 microvolts (at 1 and 10 volts). For example, Optimation AC 104.

(d) AC/DC laboratory transfer standard for calibration of the AC source. For example, Holt Model 6 Thermal Transfer Voltmeter.

(e) Five digit DVM (optional). For example, Dana Model 5700 DVM.

(f) Standard resistors: 1K, 10K, 100K, 1 meg, and 10 megohm.

5.5 TOOLS

(a) Insulated blade-type calibration tool.

(b) No. 1 Phillips screwdriver.

5.6 OTHER

(a) 10,000 ohm 1/4 watt, 5% carbon resistor.

(b) 51,000 ohm 1/4 watt, 5% carbon resistor.

(c) 2 megohm 1/4 watt, 5% carbon resistor.

5.7 This section combines the calibration adjustments for the Digitizing and Display portion with the Accessory portion. If desired, one portion, the Accessory Module for example, can be calibrated separately, provided that the other portion is known to be calibrated. Each calibration adjust heading is clearly marked whether for Digitizing and Display or Accessory Module 230.

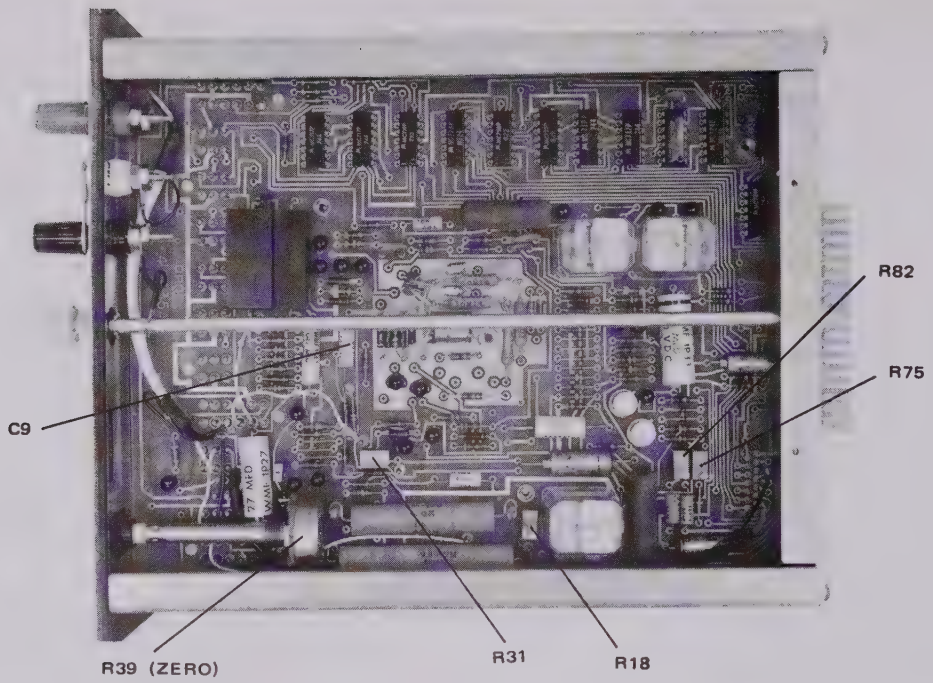


Figure 5.1 - Model 230 Isolator

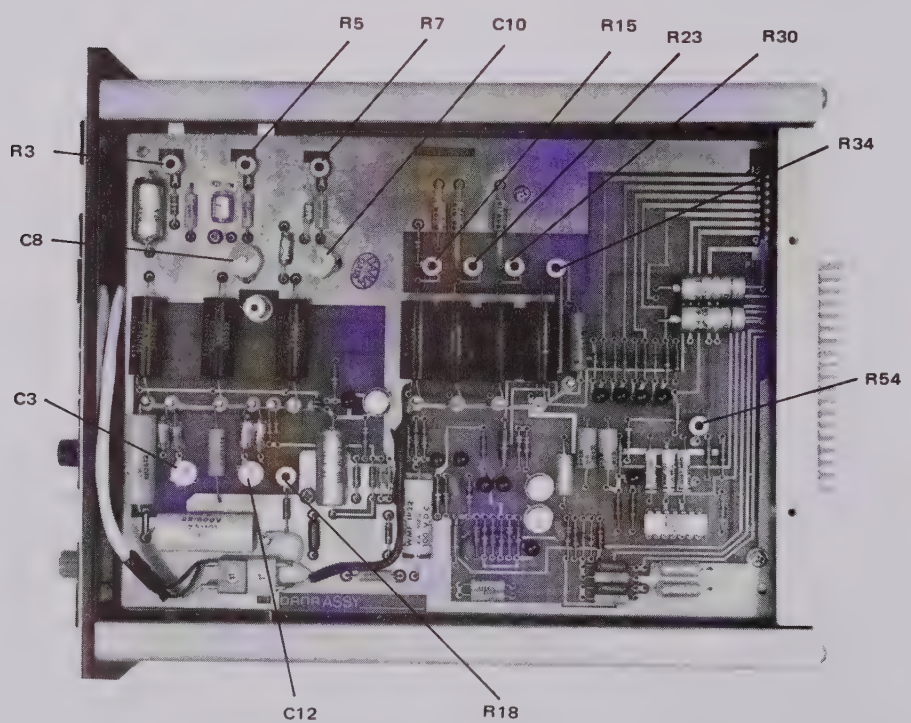


Figure 5.2 - Model 230 AC & Ohms Converter

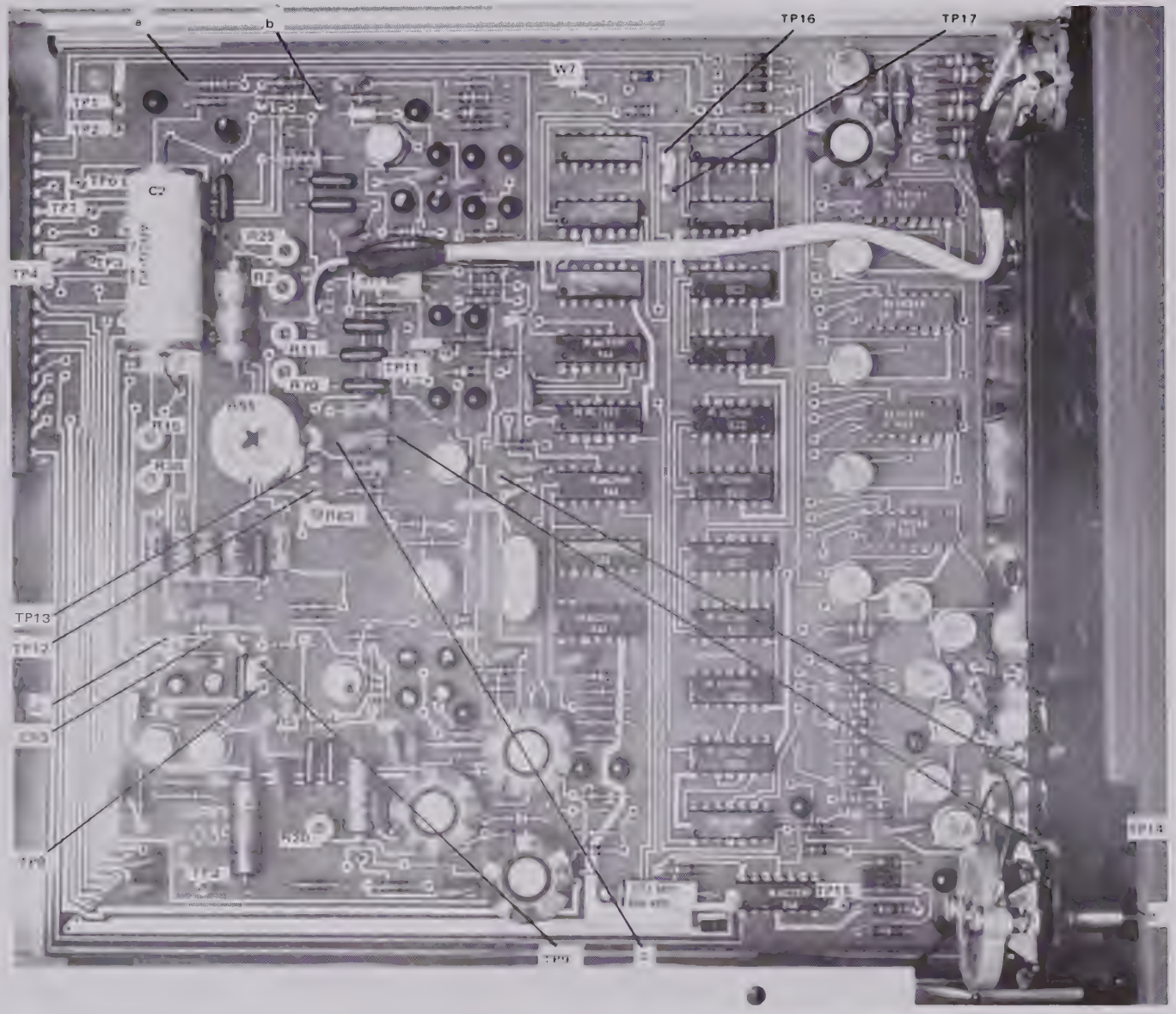


Figure 5.3 - Display (Readout) Module

5.8 PREPARATION

(a) Remove both the top and bottom covers of the DMM. Set the Model 4400 OFF-ON-HOLD switch to ON and allow at least 30 minutes for the instrument to warm up.

5.9 ADJUST RAMP GENERATOR ZEROS (Display Module)

(a) Remove Accessory Module.

(b) Connect a jumper between TP4 (Ramp Input) and TP6 (Reference Common).

(c) Connect a 10K ohm resistor across capacitor C2.

(d) Connect a jumper from the junction of R13 and the base of Q3 (point a on figure 5.3) to TP6.

(e) Connect the positive side of the precision calibrator source in series with a 2 megohm resistor to the junction of R33 and R34 (point b). Connect the low side of the source to TP6.

(f) Connect the positive input of the microvoltmeter in series with a 51K ohm isolation resistor to the same junction of R33 and R34. Connect the low side to TP6.

(g) Adjust the calibrator voltage for a reading of zero ± 30 microvolts.

(h) Connect the positive input of the microvoltmeter in series with the 51K ohm isolation resistor to the top of C2 (figure 5.4). Retain the low side at TP6.

(i) Adjust the voltage zero R25 for a reading of zero ± 30 microvolts.

(j) Move the microvoltmeter positive input to TP11.

(k) Adjust the current zero R11 for a reading of zero ± 30 microvolts.

(l) Verify results of steps f, h and j to establish optimum zeros.

(m) Do not remove jumpers or voltages until after paragraph 5.10.

5.10 ADJUST NULL DETECTOR ZERO (Display module)

(a) Connect a jumper between TP1 and TP6 as shown in figure 5.5.

(b) Attach another jumper from the junction of R56 and R57 (point c) to TP6.

(c) With the low side of the microvoltmeter still attached to TP6, connect the positive input to the summing node junction of R57, R58, and R59 (point d).

(d) Adjust the current zero, R63, to read zero ± 30 microvolts.

(e) Remove the jumper from point c to TP6.

(f) Remove all other jumpers, resistors and voltages.

(g) Reinstall Isolator Module.

5.11 ADJUST INTERNAL REFERENCE (Display Module)

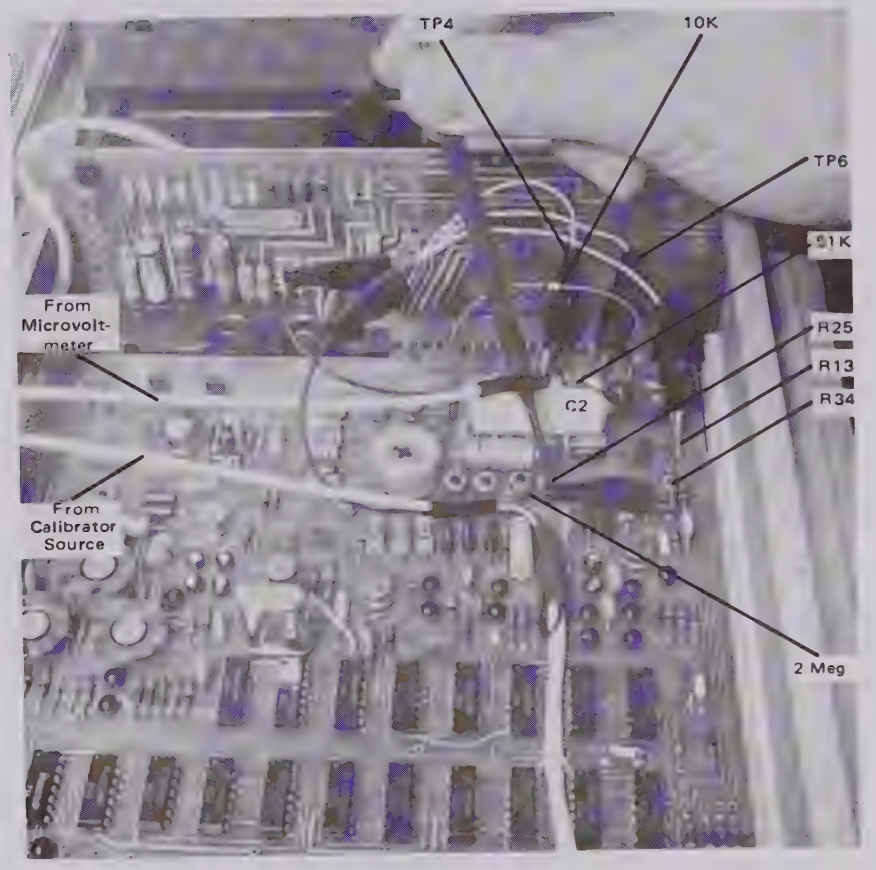


Figure 5.4 - Test Setup - Ramp Zero

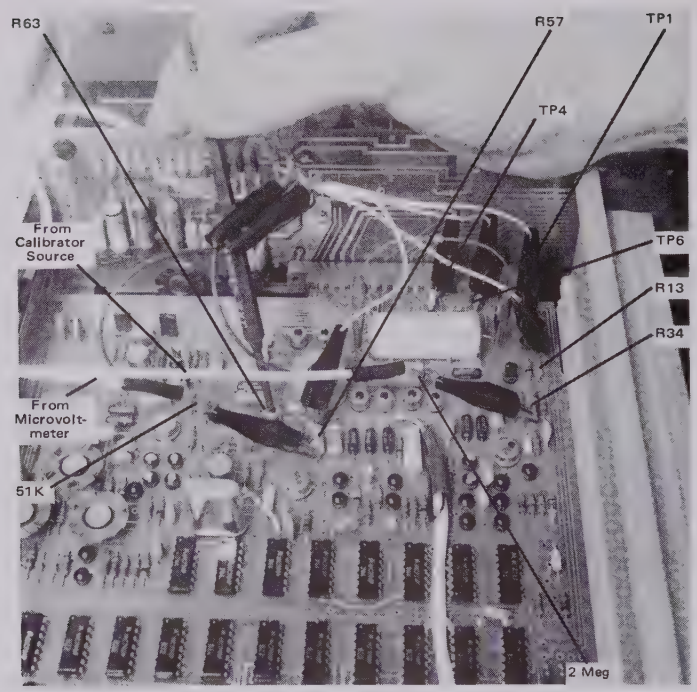


Figure 5.5 - Test Setup - Null Detector Zero

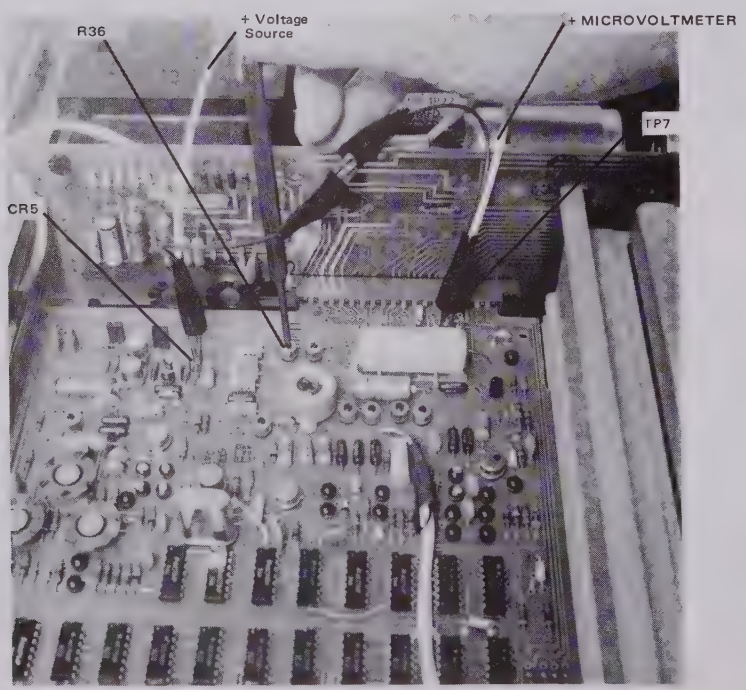


Figure 5.6 - Test Setup - Reference Calibration

(a) Set the Voltage Calibrator to the reference voltage value recorded on the zener serial tag mounted on the back of the display shield.

(b) Connect the positive side of the voltage source to the cathode side of CR5 (point e) and the positive input of the microvoltmeter to TP7 (figure 5.6).
CAUTION: Avoid shorting cathode of CR5 to adjacent straps.

(c) Connect the negative side of the calibrator to the low side of the microvoltmeter and tie their case connections together.

(d) Adjust the zener calibration potentiometer R36 for a microvoltmeter reading of zero $\pm$ 10 microvolts.

(e) Remove the leads to CR5 and TP7.

(f) (optional method — can be used in place of steps a through e)

Connect the DVM common lead to TP6 and the input lead to TP7. Adjust the potentiometer R36 for a DVM reading equal to the value recorded on the zener serial tag (DVM reads -polarity).

5.12 DC ISOLATOR ZERO (Accessory Module)

(a) Select 0.1 volt scale.

(b) Connect a jumper across C9 (.1 μf capacitor, see figure 5.1).

(c) Connect microvoltmeter between TP2 (+) and TP6 (—) on display module (see figure 5.3).

(d) Adjust front panel ZERO control (R39) for a microvoltmeter reading of 0 $\pm$ 200 microvolts.

(e) Remove short across C9 and remove microvoltmeter leads.

(f) Place a 10 megohm resistor across the input terminals.

(g) Momentarily short input terminals.

(h) Adjust the current zero pot (R31, see figure 5.1) for a stable reading on the readout.

(i) Repeat steps (g) and (h) until a stable reading of all zeros is obtained on the readout.

5.13 ADJUST DMM POLARITY (Display Module)

(a) Select the 10 volt range. Connect the DMM input terminals to a DC voltage source and set the voltage source output to -.002 volts.

(b) Adjust the null detector voltage zero control R70 for a display reading bouncing between -0.001 and -0.002 volts.

(c) Set input to +0.002 volts. Adjust R20 (voltage zero control for the auto polarity) for a display reading bouncing between 0.001 and 0.002 volts.

5.14 ADJUST POSITIVE AND NEGATIVE GAIN (Display Module)

(a) Set the calibrate control R1 on the front panel to its mechanical center.

(b) Set the voltage source output to -9.9990 volts.

(c) Adjust the rough calibration control R2 for a DMM display reading of 9.9 volts. Adjust R1 for a display reading bouncing between -9.998 and -9.999.

(d) Reverse the polarity of the voltage source (+9.9990).

(e) Adjust the positive polarity gain control R55 for a display reading bouncing between 9.998 and 9.999 volts.

(f) Repeat steps a through d for interaction between controls.

5.15 ADJUST VOLTAGE DIVIDER (Accessory Module, Figure 5.1)

(a) Set the voltage source output to -0.10000 volts and the DMM range to .1.

(b) Adjust the millivolt gain control R82 for a display of -.10000.

(c) Select the 1 volt range and set the voltage source to -1.00000.

(d) Adjust the 1 volt gain control R75 for a display of -1.0000.

(e) Select the 1000 volt range and set the voltage source to -1000.00.

(f) Adjust the 1000 volt divider control R18 for a display of -1.000.0.

(g) Apply -100V to the input and verify that readout indicates -100.00 volts.

5.16 ADJUST CALIBRATE TEST (Display Module)

(a) Select a DMM range of 1.

(b) Manually depress and hold in the calibration switch.

(c) Adjust R15 (see figure 5.3) for a display reading of -1.0000.

5.17 ADJUST AC VOLTAGE DIVIDER (Accessory Module, Figure 5.2)*

(a) Connect DMM input terminals to the AC voltage source.

(b) Select AC function and autorange.

(c) Set AC source output to 1 volt at 400 Hz.

(d) Adjust the 1 volt, 400 Hz control (R18) for a DMM display reading of 1.0000.

(e) Set AC source to 500.00 volts at 400 Hz.

(f) Adjust the 500 volts, 400 Hz control (R3) for a DMM display reading of 500.00.

(g) Repeat steps c through f as necessary.

(h) Set the AC source to the following series of AC voltages and adjust the appropriate controls as called out on the top plate of the Accessory Module.

* On 4470 Models remove power, place 230 module on extender board and reapply power.

VOLTS RMS	FREQUENCY	ADJUST
0.90000	400 Hz	R18
0.90000	10 kHz	C12
9.0000	400 Hz	R7
9.0000	10 kHz	C10
90.000	400 Hz	R5
90.000	10 kHz	C8

5.18 OHMS CONVERTER RANGE ADJUSTMENT (Figure 5.2)*

(a) Set FUNCTION to KILOHMS and RANGE to AUTO.

(b) Connect input to a 1000 - ohms standard and adjust R54 for readout of 1.0000 (plus any zero offset present with test leads shorted).

(c) Connect input to a 10 - megohm standard and adjust R34 for readout of 10000.

(d) Connect input to a 10 - kilohm standard and adjust R15 for readout of 10.000.

(e) Connect input to a 100 - kilohm standard and adjust R23 for readout of 10.00.

(f) Connect input to a 1 - megohm standard and adjust R30 for readout of 1000.0.

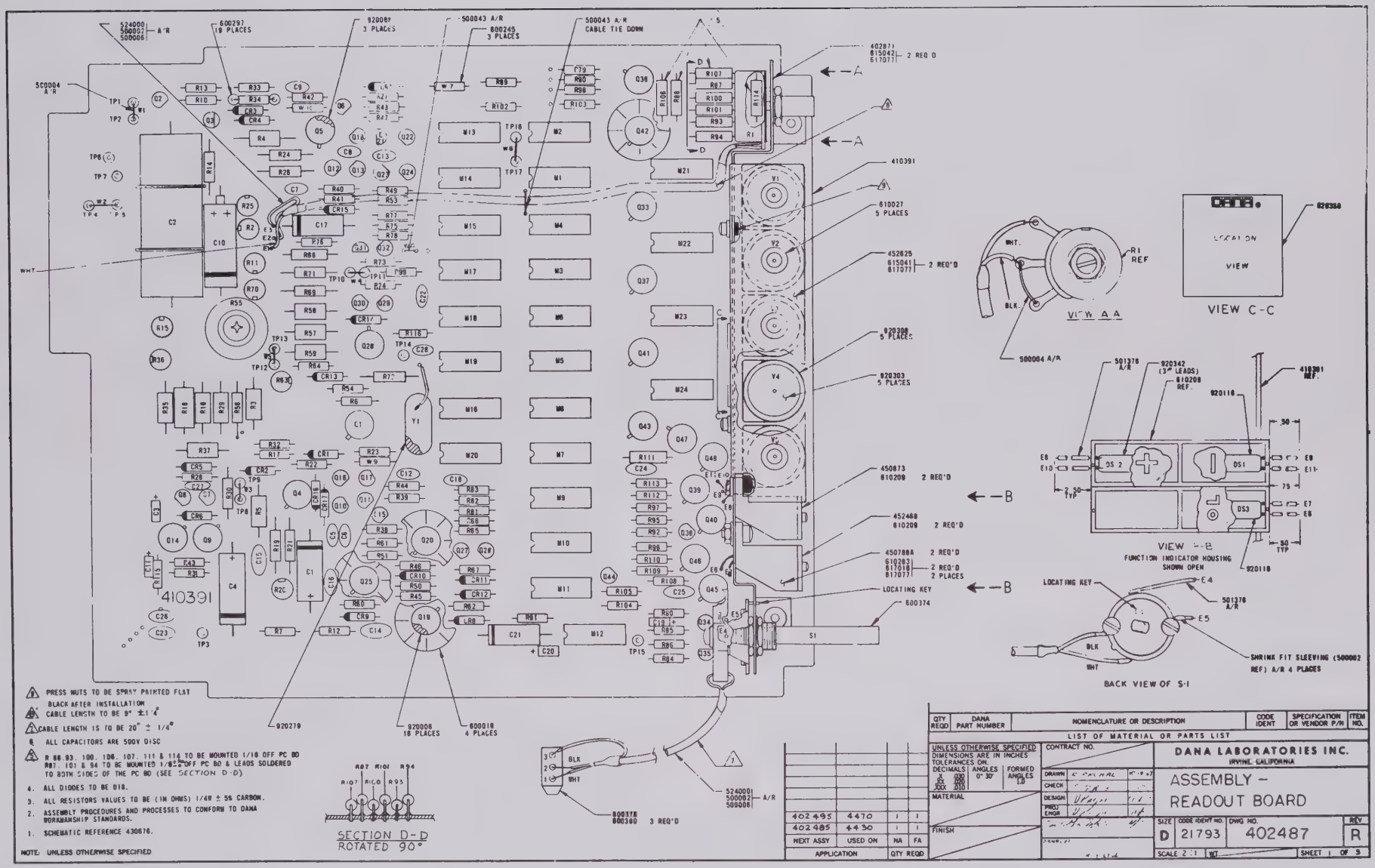
* On 4470 Models remove power, place 230 module on extender board and reapply power.

SECTION 6

DRAWINGS

6.1 DRAWINGS

Readout Assembly	402487
Readout Schematic	430676
Power Supply Assembly, 4430	402488
Power Supply Assembly, 4470	402497
PCB Assembly - Power Supply, 4470	402498
Power Supply Schematic	430677
PCB Assembly - Power Supply, 4430	402489
PCB Assembly, Isolator	402560
Schematic, Isolator	430709
PCB Assembly, AC & Ohms Converter	402581
Schematic, AC & Ohms Converter	430829



⚠1 PRESS NUTS TO BE SPRAY PAINTED FLAT BLACK AFTER INSTALLATION

⚠2 CABLE LENGTH IS TO BE 9" ±1/4"

⚠3 CABLE LENGTH IS TO BE 20" ± 1/4"

4. ALL CAPACITORS ARE 500V DISC

⚠5 R 88 93, 100, 106, 107, 111 & 114 TO BE MOUNTED 1/10 OFF PC BD R87, 101 & 94 TO BE MOUNTED 1/8" OFF PC BD & LEADS SOLDERED TO BOTH SIDES OF THE PC BD (SEE SECTION D-D)

4. ALL DIODES TO BE D18.

3. ALL RESISTORS VALUES TO BE (IN OHMS) 1/4W ± 5% CARBON.

2. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM TO DANA WORKMANSHIP STANDARDS.

1. SCHEMATIC REFERENCE 430676.

NOTE: UNLESS OTHERWISE SPECIFIED

QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.
402495	4470	1	1		
402485	4430	1	1		
NEXT ASSY	USED ON	MA	FA		
APPLICATION		QTY REQD			

LIST OF MATERIAL OR PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON: DECIMALS .XX ±.030 .XXX ±.010 ANGLES 0° 30' FORMED ANGLES ±1°

MATERIAL

FINISH

CONTRACT NO.

DRAWN

CHECK

DESIGN

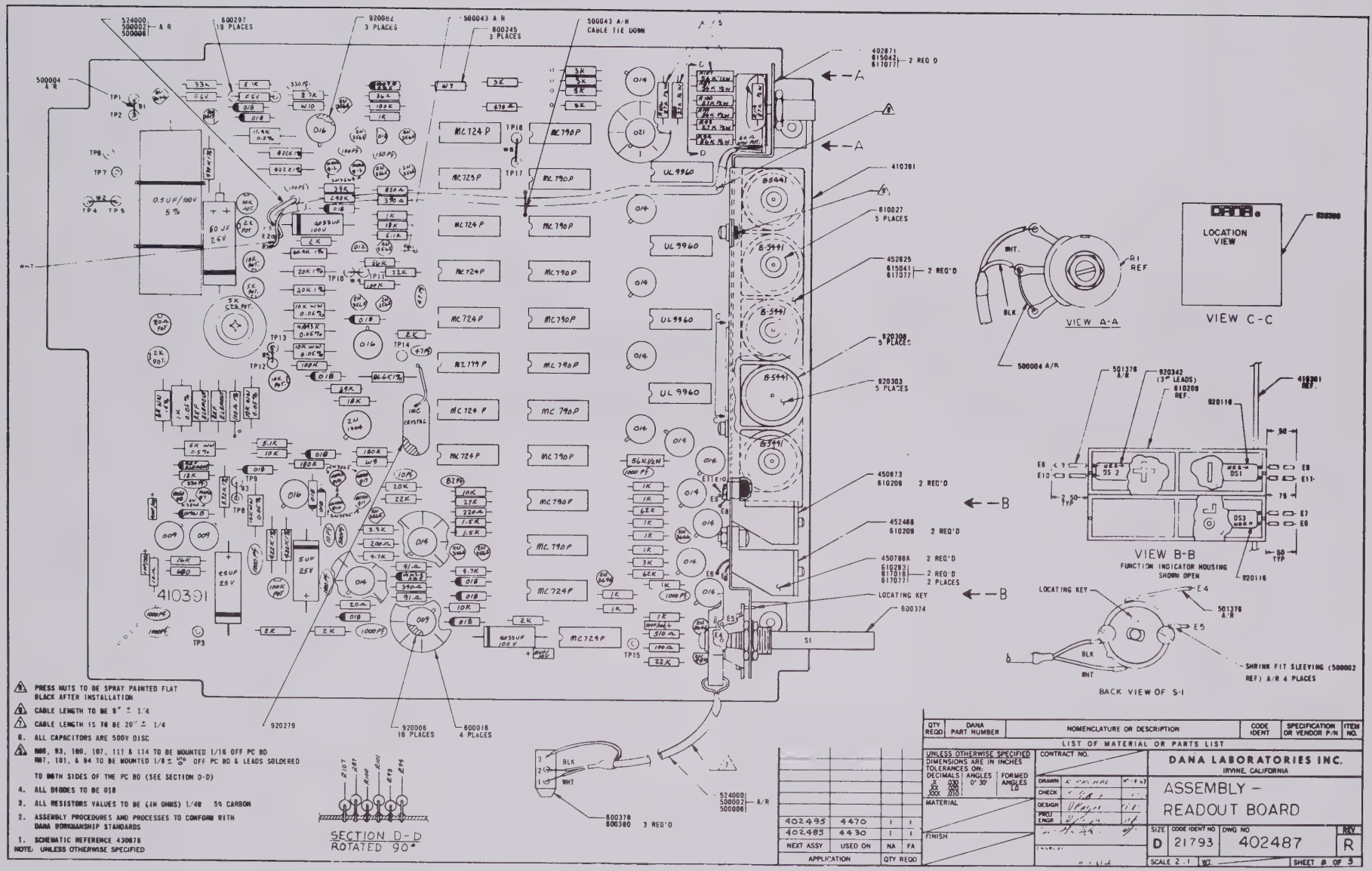
PROJ ENGR

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ASSEMBLY - READOUT BOARD

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	402487	R

SCALE 2:1 WT SHEET 1 OF 3



1. SCHEMATIC REFERENCE 430078
NOTE: UNLESS OTHERWISE SPECIFIED

2. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM WITH DANA BORGMANSHIP STANDARDS

3. ALL RESISTORS VALUES TO BE (IN OHMS) 1/4W 5% CARBON

4. ALL DIODES TO BE 018

5. ALL CAPACITORS ARE 500V DISC

6. CABLE LENGTH IS TO BE 20" ± 1/4

7. CABLE LENGTH TO BE 9" ± 1/4

8. PRESS NUTS TO BE SPRAY PAINTED FLAT BLACK AFTER INSTALLATION

QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.
1	402495	4470			
1	402485	4430			
NEXT ASSY	USED ON	NA	FA		
APPLICATION		QTY REQD			

LIST OF MATERIAL OR PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON: DECIMALS ANGLES FORMED ANGLES 1.0

MATERIAL

FINISH

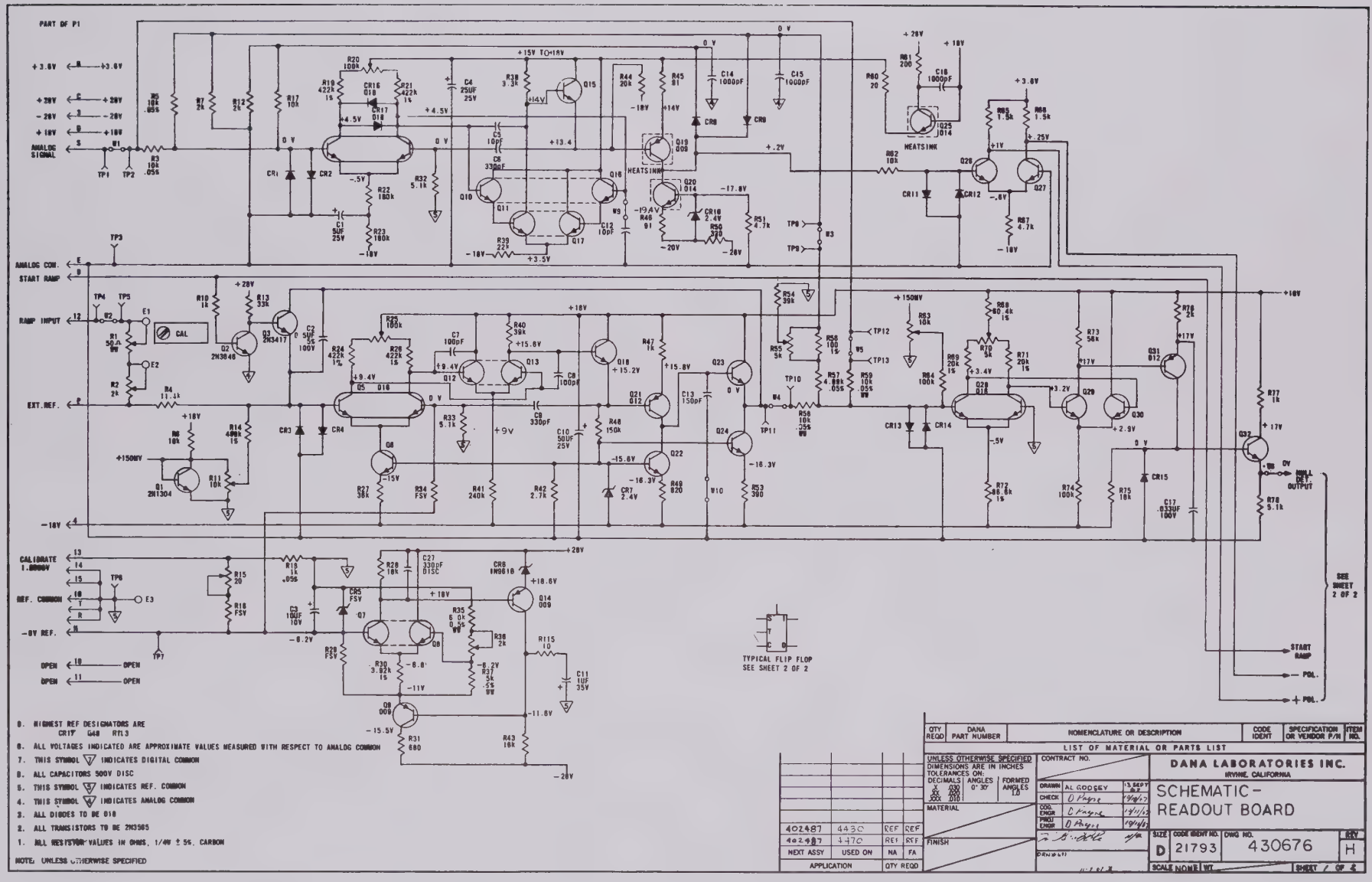
CONTRACT NO.

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ASSEMBLY – READOUT BOARD

SIZE	CODE IDENT NO	DWG NO	REV
D	21793	402487	R

SCALE 2:1 WT. SHEET 8 OF 5



8. HIGHEST REF DESIGNATORS ARE CR17 G48 RT13
6. ALL VOLTAGES INDICATED ARE APPROXIMATE VALUES MEASURED WITH RESPECT TO ANALOG COMMON
7. THIS SYMBOL ▽ INDICATES DIGITAL COMMON
8. ALL CAPACITORS 500V DISC
5. THIS SYMBOL ▽ INDICATES REF. COMMON
4. THIS SYMBOL ▽ INDICATES ANALOG COMMON
3. ALL DIODES TO BE D10
2. ALL TRANSISTORS TO BE 2N3585
1. ALL RESISTOR VALUES IN OHMS, 1/4W ± 5%, CARBON

NOTE: UNLESS OTHERWISE SPECIFIED

NEXT ASSY	USED ON	NA	FA
402487	443C	REF	REF
402487	4470	REF	REF

APPLICATION | QTY REQD

QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.

LIST OF MATERIAL OR PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON: DECIMALS | ANGLES | FORMED ANGLES
X .020 | 0° 30' | 1.0
.XX .010
.XXX .010
MATERIAL
FINISH

CONTRACT NO.

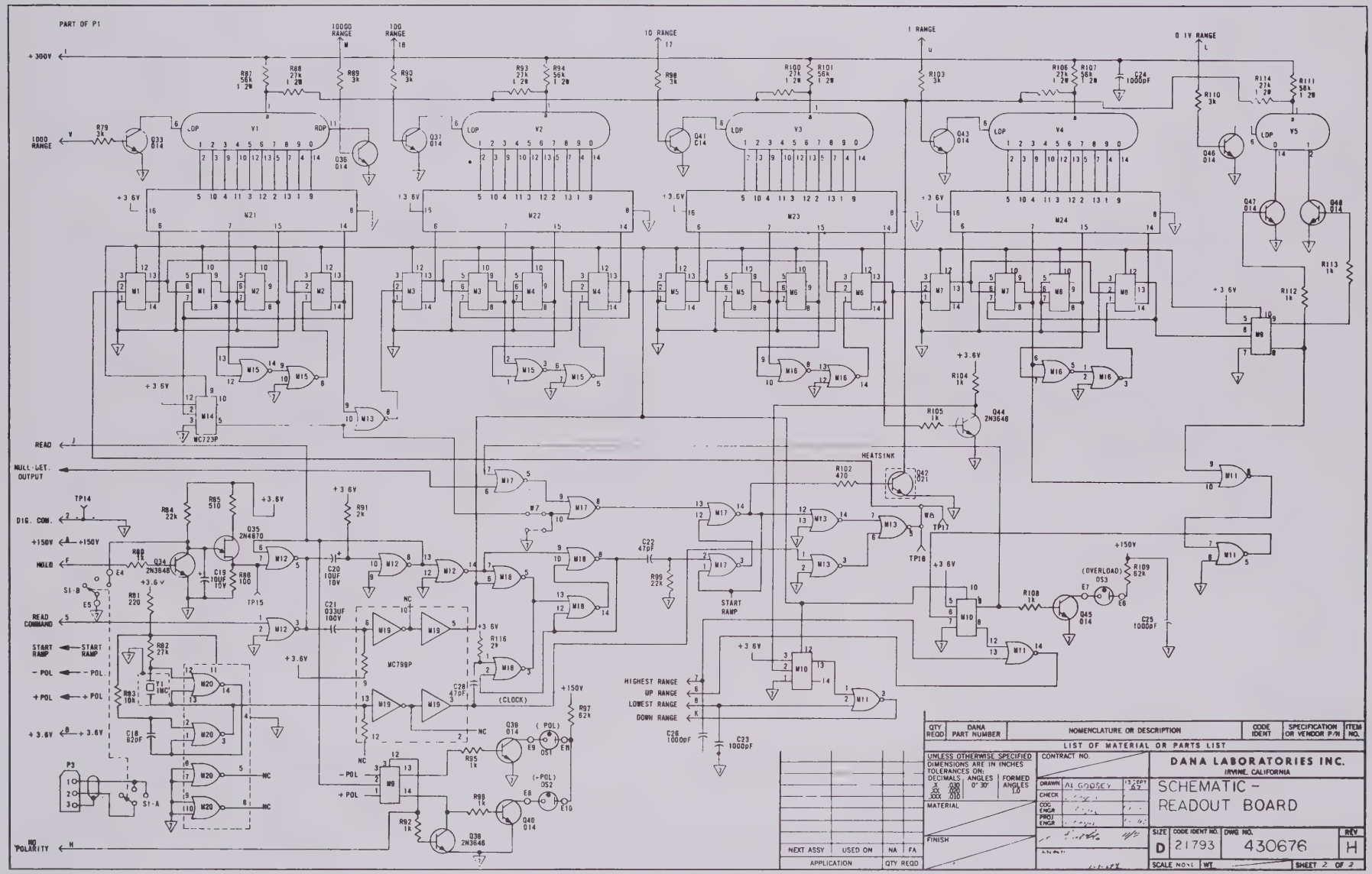
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

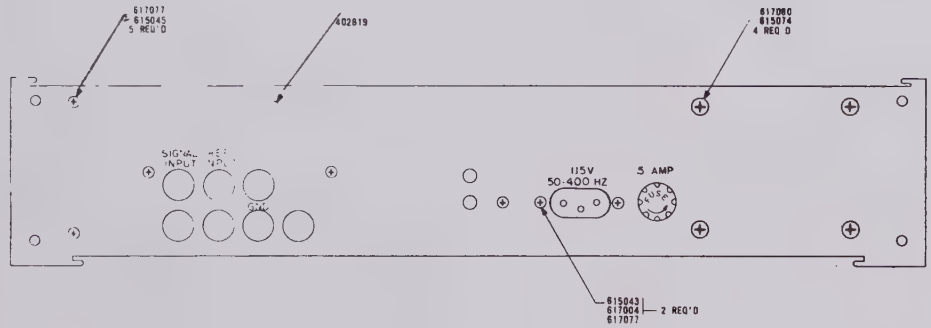
DRAWN	AL GOOSEY	13 SEPT 67
CHECK	D Payne	19/9/67
COG ENGR	D Payne	19/11/67
PROJ ENGR	D Payne	19/9/67

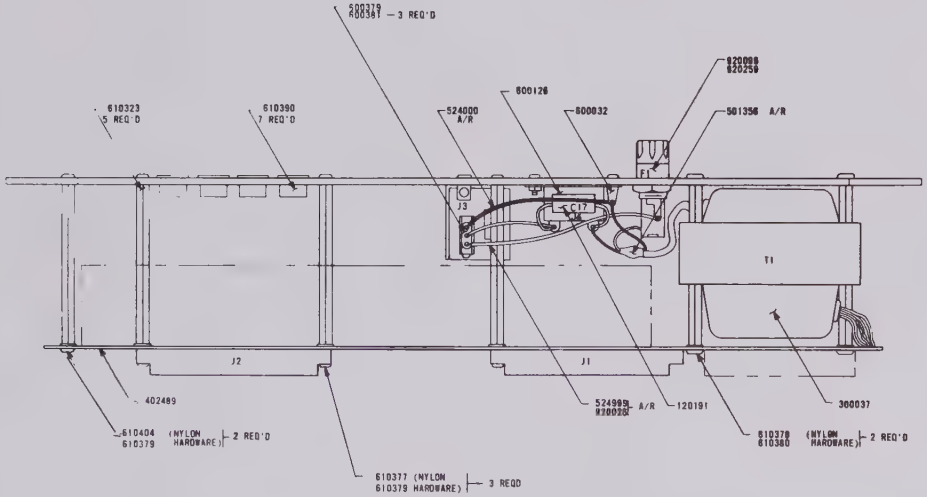
SCHEMATIC - READOUT BOARD

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	430676	H

SCALE NONE | WT | SHEET 1 OF 2

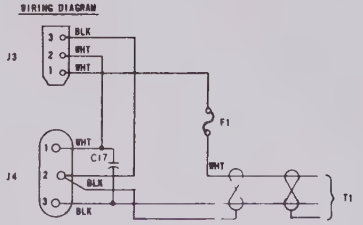

PART OF P1
+300V
10000 RANGE
100 RANGE
10 RANGE
1 RANGE
0.1V RANGE
1000 RANGE
READ
NULL-DET. OUTPUT
DIG. COM.
+150V
HOLD
READ COMMAND
START RAMP
-POL
+POL
+3.6V
NO POLARITY
HEATSINK
MC723P
MC799P
(CLOCK)
(OVERLOAD)
HIGHEST RANGE
UP RANGE
LOWEST RANGE
DOWN RANGE
NEXT ASSY
USED ON
APPLICATION
QTY REQD
NA
FA
QTY REQD
PART NUMBER
NOMENCLATURE OR DESCRIPTION
CODE IDENT
SPECIFICATION OR VENDOR P/N
ITEM NO.
LIST OF MATERIAL OR PARTS LIST
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON: DECIMALS ANGLES FORMED ANGLES
CONTRACT NO.
DANA LABORATORIES INC.
IRVINE, CALIFORNIA
DRAWN
CHECK
ENGR
PROJ ENGR
MATERIAL
FINISH
SCHEMATIC - READOUT BOARD
SIZE
CODE IDENT NO.
DWG NO.
REV
D
21793
430676
H
SCALE NONE
WT
SHEET 2 OF 2





WIRE LIST			
402489	E#	COLOR	T1
	2	GY	
	9	BLU	
	3	VIO	
	4	BRN	
	A	GRN	
	8	ORG	
	7	YEL	
	10	BLK	
	5	RED	
402489	1	WHT	T1

WIRING DIAGRAM



2. SCHEMATIC REF NO 430877

1 ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM WITH DANA WORKMANSHIP STANDARDS

NOTE: UNLESS OTHERWISE SPECIFIED

QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P'N	ITEM NO.
		LIST OF MATERIAL OR PARTS LIST			

402485	4430	1	1
NEXT ASSY	USED ON	NA	FA
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON: DECIMALS .XX ±.030 .XXX ±.010 | ANGLES 0° 30' | FORMED ANGLES ±1.0

CONTRACT NO.

MATERIAL

FINISH

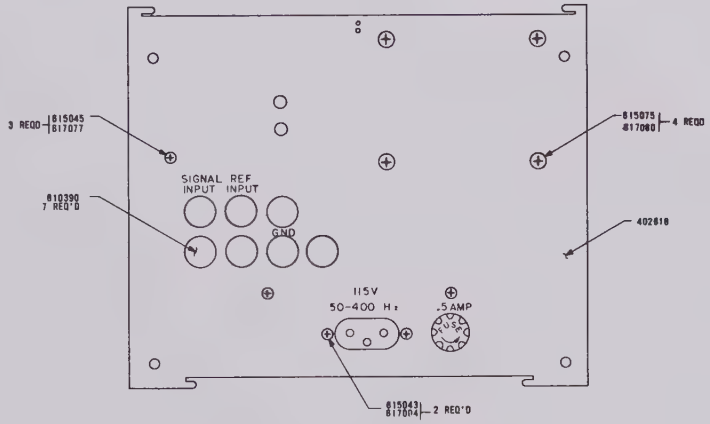
DRAWN	R. GODSEY	1962
CHECK		
DESIGN		
PROJ ENGR		

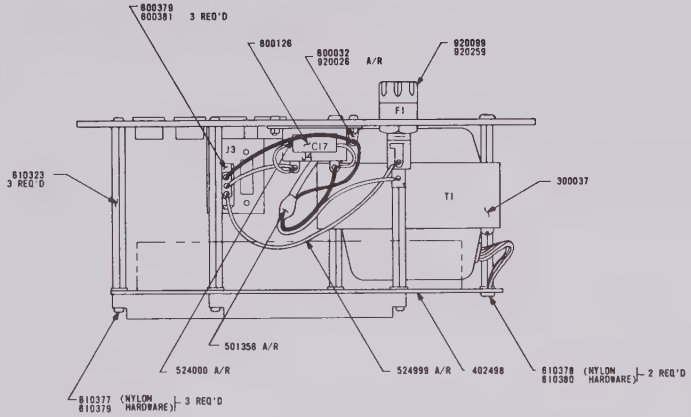
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

POWER SUPPLY ASSY
FULL RACK

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	402488	F

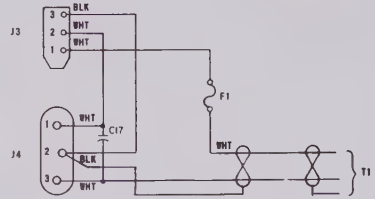
SCALE 1/1 WT SHEET 1 OF 2





WIRE LIST			
402498	E#	COLOR	T1
	5	RED	
	9	BLU	
	7	YEL	
	10	BLK	
	3	VIO	
	1	WHT	
	2	GY	
	6	ORG	
	4	BRN	
402498	8	GRN	T1

WIRING DIAGRAM



QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.
402590	4470	1	1		
402495	4470	1	1		
NEXT ASSY	USED ON	NA	FA		
APPLICATION		QTY REQD			

LIST OF MATERIAL OR PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON: DECIMALS X .030 XX .020 XXX .010 | ANGLES 0° 30' | FORMED ANGLES ±1°

MATERIAL

FINISH

CONTRACT NO.

DRAWN AL GODSEY 6/26/68
CHECK [illegible] 10/15/68
DESIGN [illegible] 10/15/68
PROJ ENGR [illegible] 10/16/68

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

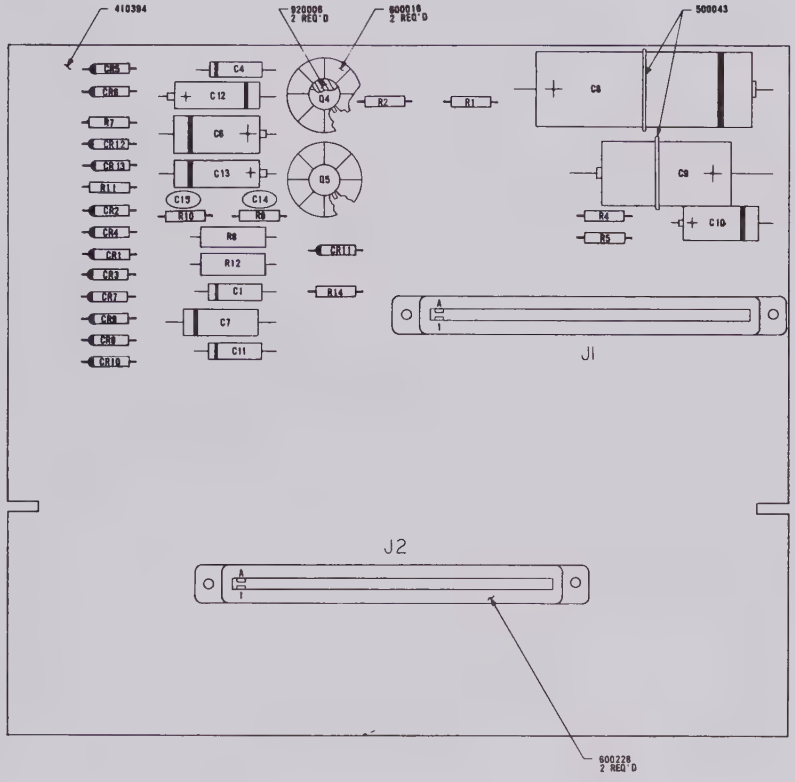
POWER SUPPLY ASSY - HALF RACK

SIZE D | CODE IDENT NO. 21793 | DWG NO. 402497 | REV J

SCALE 1/1 | WT | SHEET 1 OF 2

2. SCHEMATIC REF. NO 430877
1. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM WITH DANA WORKMANSHIP STANDARDS

NOTE: UNLESS OTHERWISE SPECIFIED



P/N	DESCRIPTION	QTY
410394	PCB-PWR SUP	1
482468	INSULATOR-MYLAR	1
500002	SHRINK TUBING	A/R
500006	CABLE-SHLD	A/R
500010	TEFLON TUBING	A/R
500043	BUSS WIRE, TEFLON	A/R
500010	HEAT SINK	2
500230	CONNECTOR	2
530273	HEAT SINK	1
610345	RIVET-SEMI TUB 3/16	4
615043	SCREW-PPH 4-40	2
617004	HEX NUT, 4-40	2
617077	LOCKWASHER #4	2
620006	TRANSISTOR PAR-LS	3
620010	SOLDER-BAR	A/R
620026	SOLDER-WIRE	A/R
620297	COMPONENT CLIP	2

QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.

LIST OF MATERIAL OR PARTS LIST

40-497	4470	1	1
NEXT ASSY	USED ON	NA	FA
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON: DECIMALS X .030 XX .020 XXX .010; ANGLES 0° 30'; FORMED ANGLES 1.0

MATERIAL

FINISH

CONTRACT NO.

DRAWN	AL GODSEY	10/6/67
CHECK		
DESIGN		10/6/67
PROJ ENGR		10/6/67

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

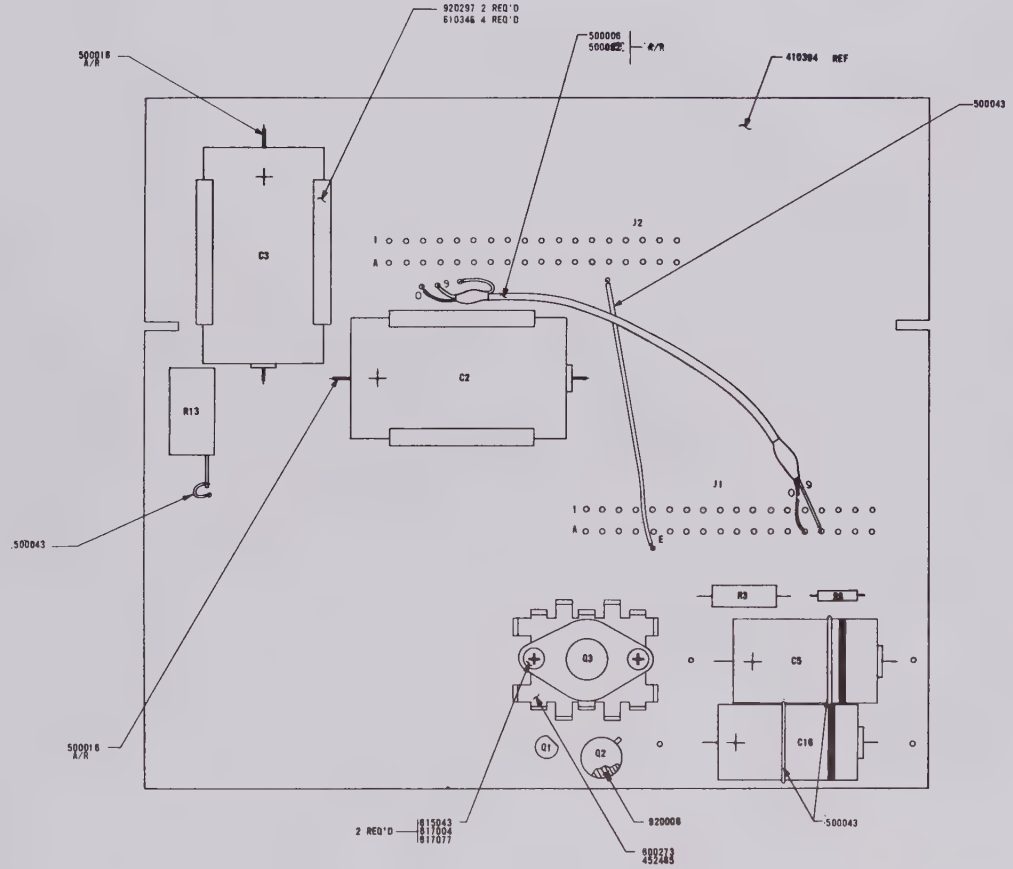
PCB ASSY-POWER SUPPLY INTERCONN HALF RACK

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	402498	E

SCALE 2 / 1 WT SHEET 1 OF 2

3. SCHEMATIC REF 430077
2. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM TO DANA WORKMANSHIP STANDARDS
1. ALL RESISTORS ARE 1/4W 5%, CARBON

NOTE: UNLESS OTHERWISE SPECIFIED



CR13	220015	IN967 B			
CR12	220015	IN967 B			
CR11	221177	1/4W2.4AZ5			
CR10	210004	SD4	R14	000511	51Ω
↕	↕	↕	R13	040083	500 /CTS
CR1	210004	SD4	R12	030007	15Ω 3W/WW
			R11	000202	2k
			R10	000151	150
C18	110077	1000UF/15V	R9	000151	150
C15	101174	.001UF/500V	R8	030007	15Ω 3W/WW
C14	101174	.001UF/500V	R7	000202	2k
C13	110043	25UF/25V	R6	000224	220k
C12	110043	25UF/25V	R5	000751	750
C11	121088	.01UF/100V	R4	000751	750
C10	110083	100UF/12V	R3	030014	220k/1W
C9	110088	15UF/200V	R2	000241	240
C8	110065	20UF/350V	R1	000241	240
C7	120072	.01UF/600V			
C6	110083	100UF/12V			
C5	110085	2000UF/ 10V	Q5	200011	009
C4	121088	.01UF/100V	Q4	200035	014
C3	110087	2000UF/35V	Q3	200030	RCA40250
C2	110087	2000UF/35V	Q2	200035	014
C1	121088	.01UF/100V	Q1	200043	2N3585
REF DES	PART NO.	DESCRIPTION	REF DES	PART NO.	DESCRIPTION

NOTE: UNLESS OTHERWISE SPECIFIED

QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.

LIST OF MATERIAL OR PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON: DECIMALS X .030 XX .020 XXX .010 | ANGLES 0° 30' | FORMED ANGLES 1.0

MATERIAL

FINISH

CONTRACT NO.

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

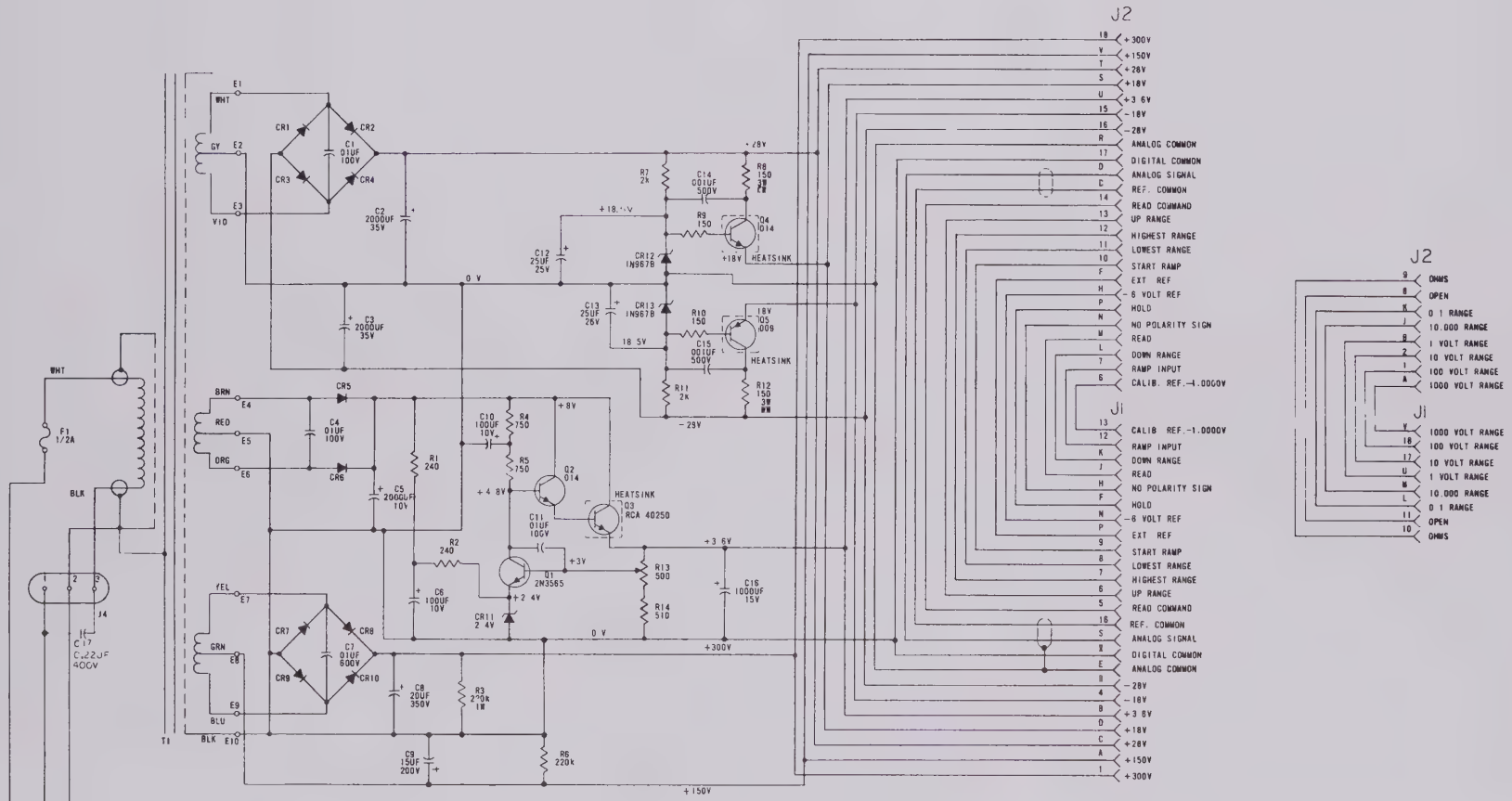
DRAWN	AL GODSEY	10 SEP 1969
CHECK		
DESIGN		
PROJ ENGR		

PCB ASSY-POWER SUPPLY/INTERCONN, HALF RACK

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	402498	E

SCALE 2/1 WT SHEET 2 OF 2

402497	1410	1	1
NEXT ASSY	USED ON	NA	FA
APPLICATION		QTY REQD	



4. ALL VOLTAGES ARE APPROXIMATE VALUES MEASURED WITH RESPECT TO ANALOG COMMON.
3. J1 AND J3 ARE CONNECTED TO THE READOUT BOARD. J2 IS CONNECTED TO THE INPUT MODULE.
2. ALL RESISTOR VALUES IN OHMS, 1/4W ± 5% CARBON.
1. ALL DIODES SD4.

NOTE: UNLESS OTHERWISE SPECIFIED

5 HIGHEST REF DESIGNATOR
C17 CR13 Q5 R14

4C1997	4470	REF	REF
J1 4458	4430	171	116
NEXT ASSY	USED ON	NA	FA
APPLICATION		QTY REQD	

QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.

LIST OF MATERIAL OR PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON:
DECIMALS | ANGLES | FORMED ANGLES
X .030 | 0° 30' | 1.0
.XX .020
.XXX .010

MATERIAL

FINISH

CONTRACT NO.

DRAWN AL GODSEY 8-9-67

CHECK

COG. ENGR

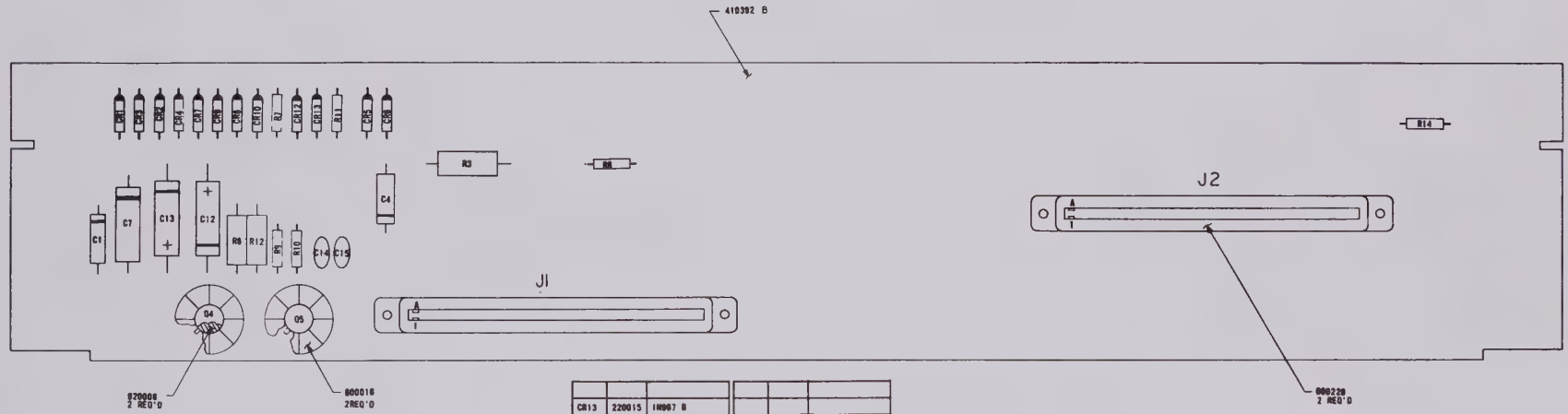
PROJ. ENGR

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC - POWER SUPPLY

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	430677	C

SCALE NONE | WT | SHEET 1 OF 1



CR13	220015	IN967 B			
CR12	220015	IN967 B			
CR11	221177	1/4W2.4AZ5			
CR10	210004	SD4	R14	000511	510Ω
⇕	⇕	⇕	R13	040063	500Ω/CTS
CR1	210004	SD4	R12	030007	150Ω/3W/WW
			R11	000202	2k
			R10	000151	150Ω
C16	110027	1000UF/15V	R9	000151	150Ω
C15	101174	.001UF/500V	R8	030007	150Ω 3W/WW
C14	101174	.001UF/500V	R7	000202	2k
C13	110043	25UF/25V	R6	000224	220k
C12	110043	25UF/25V	R5	000751	750Ω
C11	121068	.01UF/100V	R4	000751	750Ω
C10	110063	100UF/12V	R3	030014	220k/1W
C9	110008	15UF/200V	R2	000241	240Ω
C8	110085	20UF/350V	R1	000241	240Ω
C7	120072	.01UF/800V			
C6	110083	100UF/12V			
C5	110085	2000UF/10V	Q5	200011	009
C4	121068	.01UF/100V	Q4	200035	014
C3	110087	2000UF/35V	Q3	200030	RCA40280
C2	110087	2000UF/35V	Q2	200035	014
C1	121088	.01UF/100V	Q1	200043	2N3585
REF DES	PART NO.	DESCRIPTION	REF DES	PART NO.	DESCRIPTION

402488	4430	1	1
NEXT ASSY	USED ON	NA	FA
APPLICATION		QTY REQD	

QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.
		LIST OF MATERIAL OR PARTS LIST			

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
DECIMALS: X .030, .XX .020, .XXX .010 | ANGLES 0° 30' | FORMED ANGLES ±.D

MATERIAL

FINISH

CONTRACT NO.

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

DRAWN	AL GODSEY	6/5/67
CHECK		
DESIGN	DPayne	6/5/67
PROJ ENGR	DPayne	6/14/67
		6/20/67

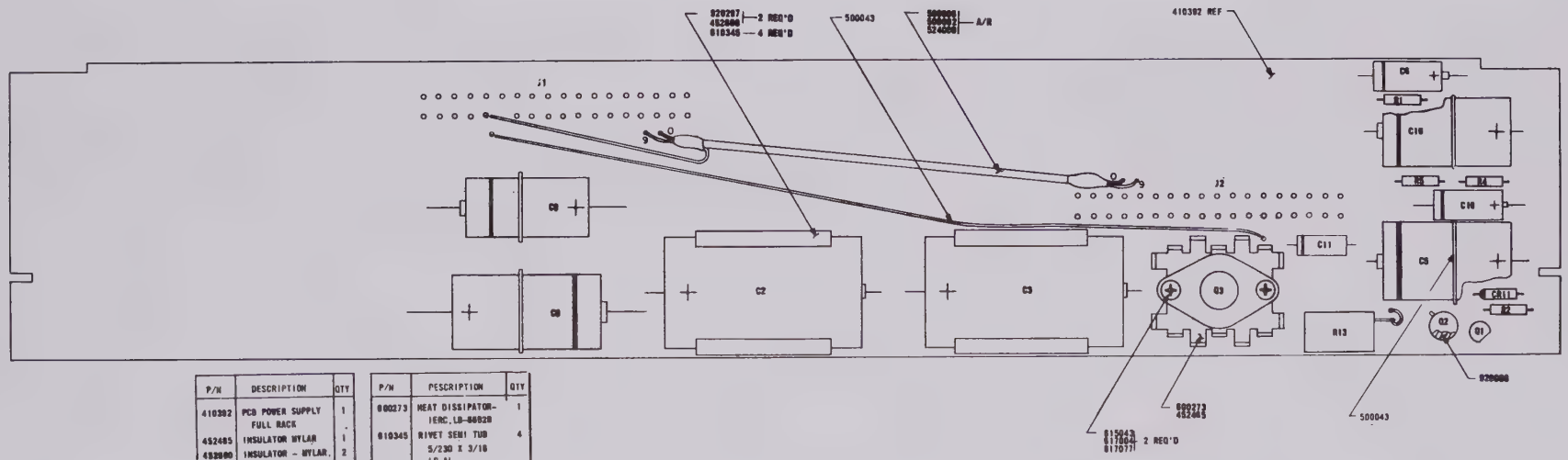
PCB ASSY-POWER SUPPLY/INTERCONN

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	402489	D

SCALE 2/1 | WT | SHEET 1 OF 2

3. SCHEMATIC REFERENCE: 430877
2. ASSEMBLY PROCESSES AND PROCEDURES TO CONFORM TO DANA WORKMANSHIP STANDARDS
1. ALL RESISTORS TO BE 1/4W, 5%, CARBON

NOTE: UNLESS OTHERWISE SPECIFIED



P/N	DESCRIPTION	QTY
410382	PCB POWER SUPPLY FULL RACK	1
452485	INSULATOR MYLAR	1
452980	INSULATOR - MYLAR, COMP-CLIP	2
500002	TUBING-SHRINK .153 ID	A/R
500008	CABLE-STORM B-24-19/38N-S2V	A/R
500043	WIRE-24GAGE WHITE TEFLON COATED	A/R
524000	WIRE-24GAGE BLK	A/R
800016	HEAT SINK IERC TIDF-032-0250	2
800228	CONN-EDGETYPE #252-10-30-180	2

P/N	DESCRIPTION	QTY
800273	HEAT DISSIPATOR-IERC, LD-66828	1
810345	RIVET SEMI TUB 5/230 X 3/16 LG AL	4
815043	SCREW PPH 4-40 X 5/16 STLS	2
817804	HEX NUT 4-40 STD STLS	2
817077	WASHER INT LOCK 4 STLS	2
920000	TRANS PAD-LARGE	3
920010	SOLDER-63/37 BAR	A/R
920020	SOLDER-WIRE .03203/37 RESIN CORE	A/R
920207	CLIP COMPONENT SEASTRUM	2

NOTE: UNLESS OTHERWISE SPECIFIED

QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.
		LIST OF MATERIAL OR PARTS LIST			

402488	4432	1	1
NEXT ASSY	USED ON	NA	FA
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON:
DECIMALS: X .030, XX .010, XXX .005
ANGLES 0° 30'
FORMED ANGLES 1.0

MATERIAL

FINISH

CONTRACT NO.

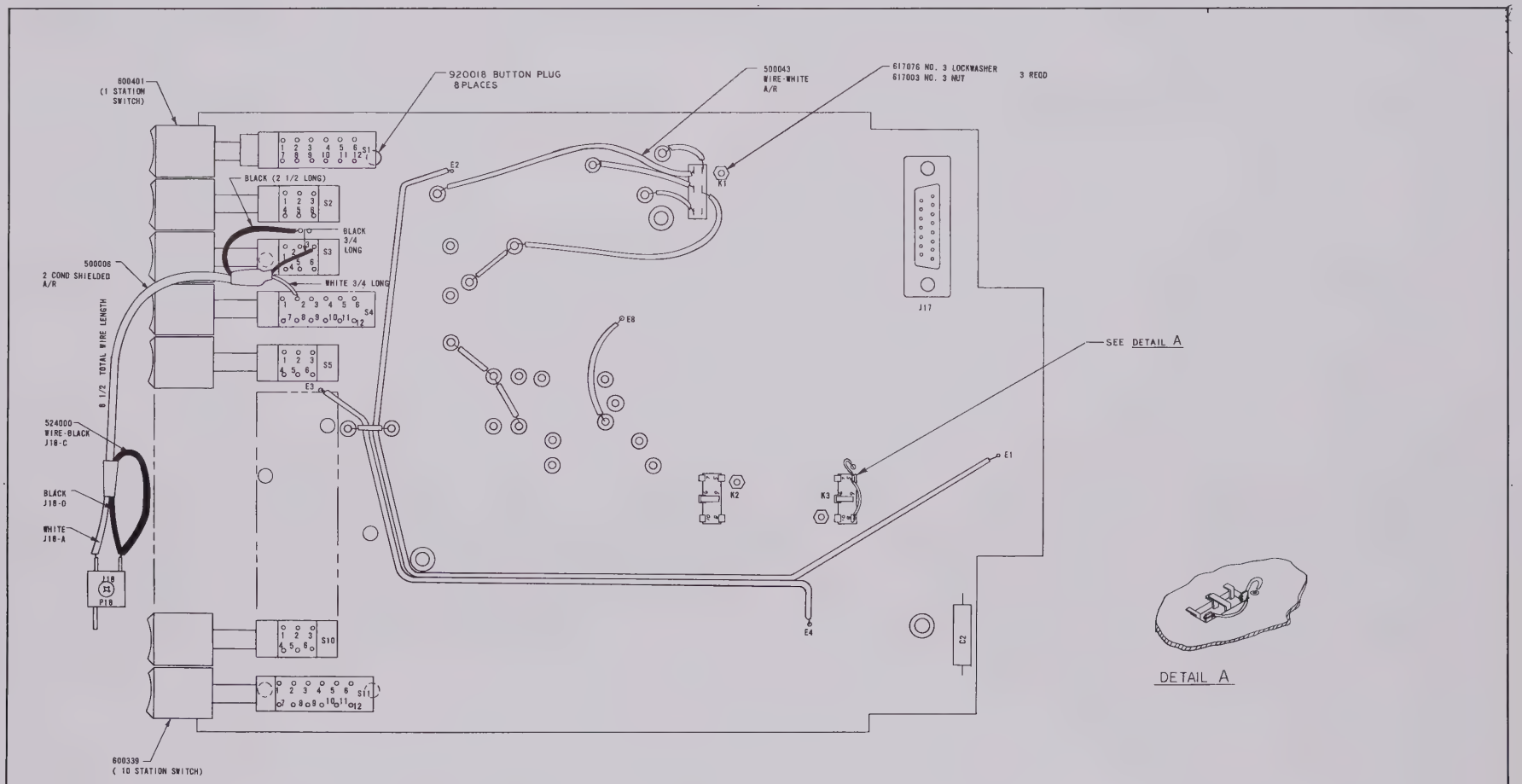
DRAWN	AL GODSEY	10 SEPT 1981
CHECK		
DESIGN		
PROJ ENGR		

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

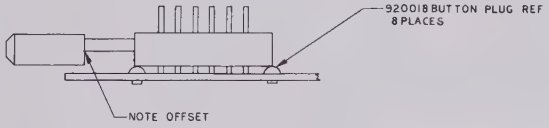
PCB ASSY - POWER SUPPLY / INTERCONN

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	402489	D

SCALE 2/1 WT | SHEET 2 OF 2



DETAIL A



NOTES: UNLESS OTHERWISE SPECIFIED

402582	230	REF	REF
NEXT DWG	USED ON	NEXT DWG	FINAL ASSY
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
DECIMALS: X .030, XX .020, XXX .010 | ANGLES: 0 30', FORMED 1° 0' | HOLE DIAMETERS: +.004 -.001

MATERIAL

FINISH

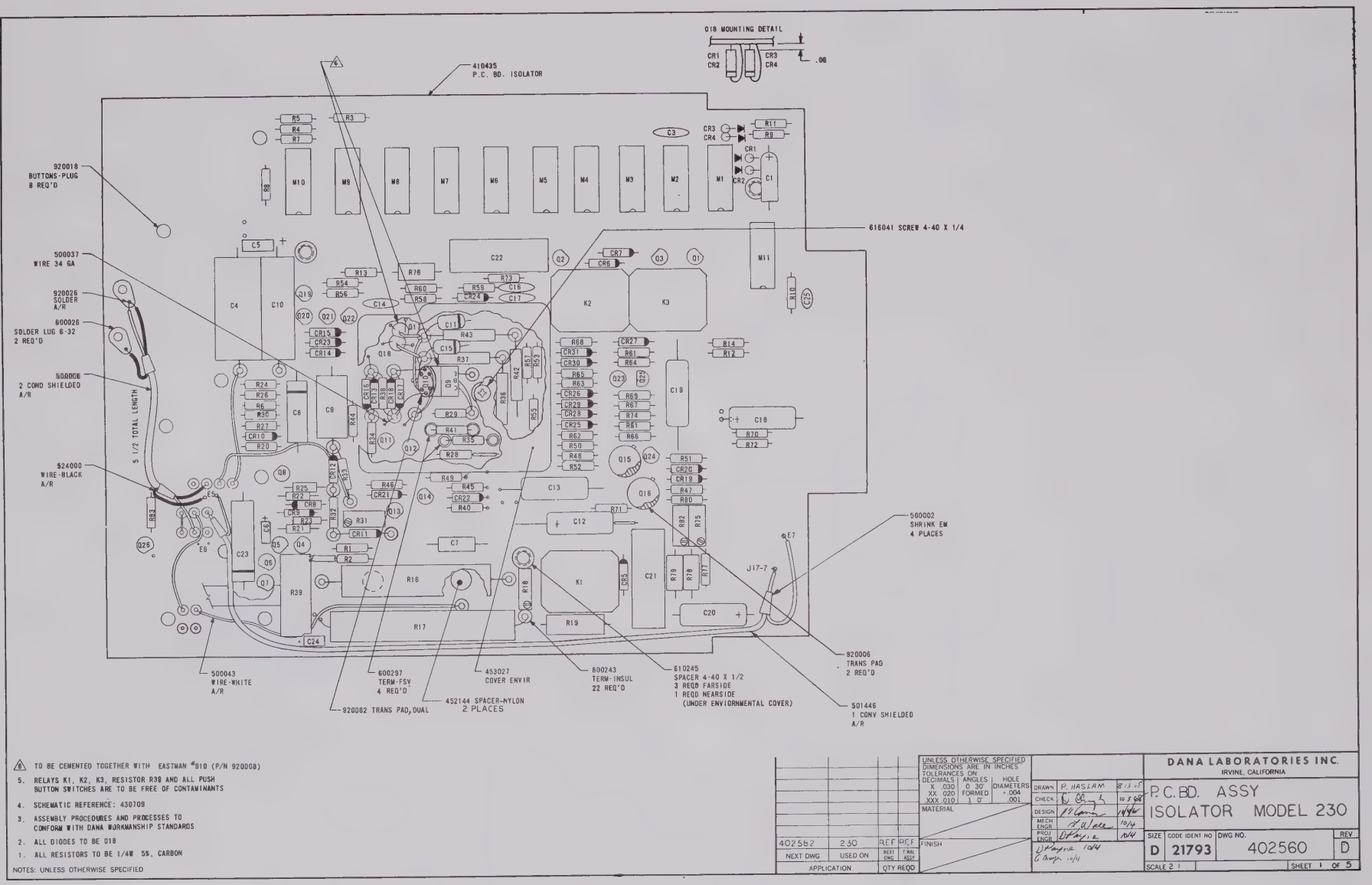
DRAWN	P. HASLAM	8-9-60
CHECK		10/3/61
DESIGN		10/4/61
MECH ENGR		10/4
PROJ ENGR		10/4

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

P.C.BD. ASSY-
ISOLATOR MODEL 230

SIZE	CODE IDENT NO	DWG NO.	REV
D	21793	402560	D

SCALE 2:1 SHEET 2 OF 5



⚠6 TO BE CEMENTED TOGETHER WITH EASTMAN #910 (P/N 920008)

5. RELAYS K1, K2, K3, RESISTOR R39 AND ALL PUSH BUTTON SWITCHES ARE TO BE FREE OF CONTAMINANTS
4. SCHEMATIC REFERENCE: 430709
3. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM WITH DANA WORKMANSHIP STANDARDS
2. ALL DIODES TO BE 018
1. ALL RESISTORS TO BE 1/4W 5%, CARBON

NOTES: UNLESS OTHERWISE SPECIFIED

NEXT DWG	USED ON	NEXT DWG	FINAL ASSY
402562	230	REF	REF
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS: X .030, XX .020, XXX .010 | ANGLES: 0 30', FORMED 1 0' | HOLE DIAMETERS: .004, .001

MATERIAL

FINISH

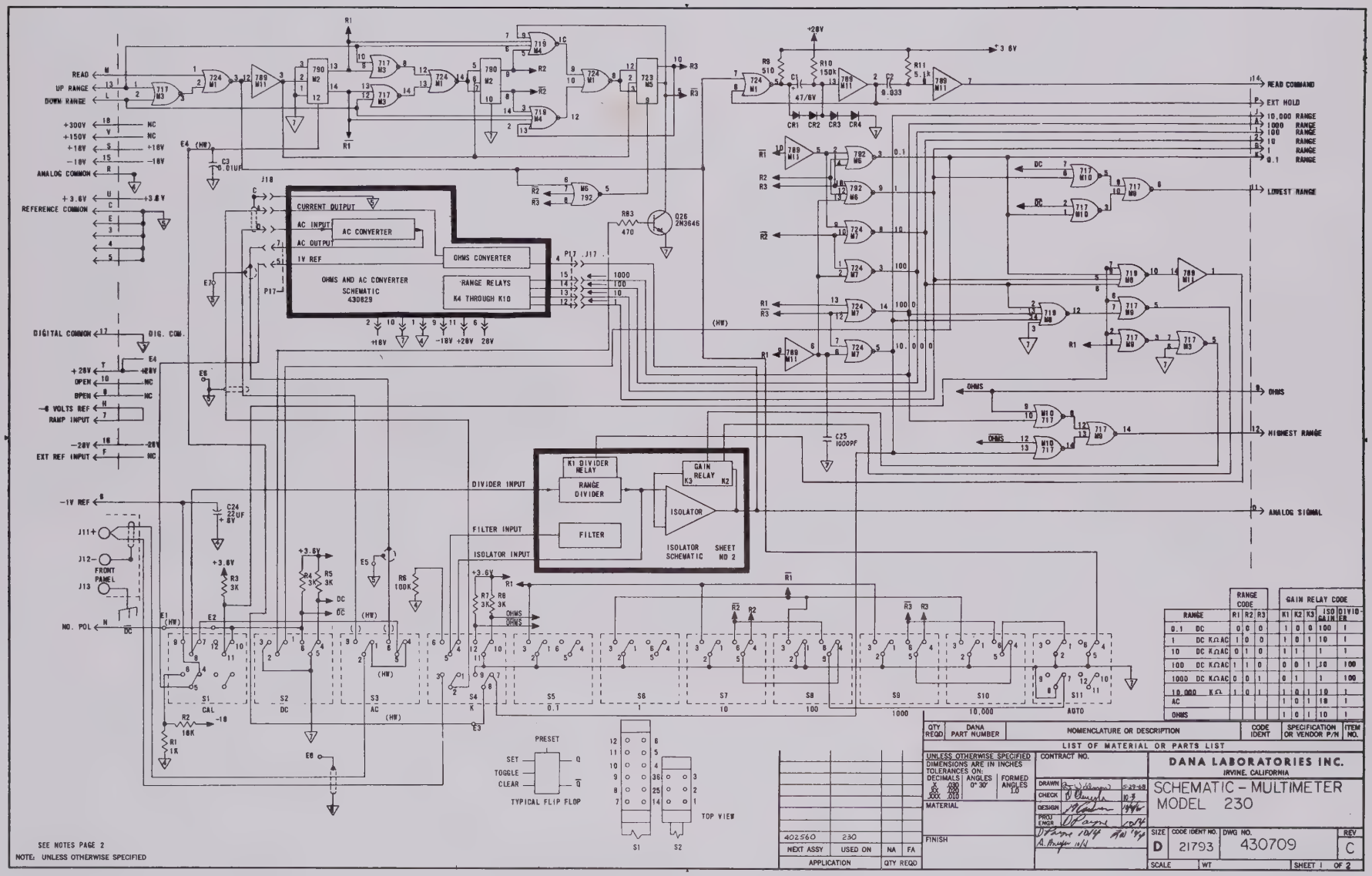
DRAWN	P. HASLAM	8/13/64
CHECK		10/5/64
DESIGN		10/14
MECH ENGR		10/14
PROJ ENGR		10/14

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

P.C. BD. ASSY
ISOLATOR MODEL 230

SIZE	CODE IDENT NO	DWG NO.	REV
D	21793	402560	D

SCALE 2 : 1 | SHEET 1 OF 5



RANGE	RANGE CODE R1	R2	R3	GAIN RELAY CODE K1	K2	K3	ISO GAIN	DIV10
0.1 DC	0	0	0				100	1
1 DC KΩAC	1	0	0	1	0	1	10	1
10 DC KΩAC	0	1	0	1	1		1	1
100 DC KΩAC	1	1	0	0	0	1	10	100
1000 DC KΩAC	0	0	1	0	1		1	100
10,000 KΩ	1	0	1	1	0	1	10	1
AC				1	0	1	10	1
OHMS				1	0	1	10	1

QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.

LIST OF MATERIAL OR PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON: DECIMALS | ANGLES | FORMED ANGLES
.XX .010 | 0° 30' | 1.0
MATERIAL
FINISH

CONTRACT NO.

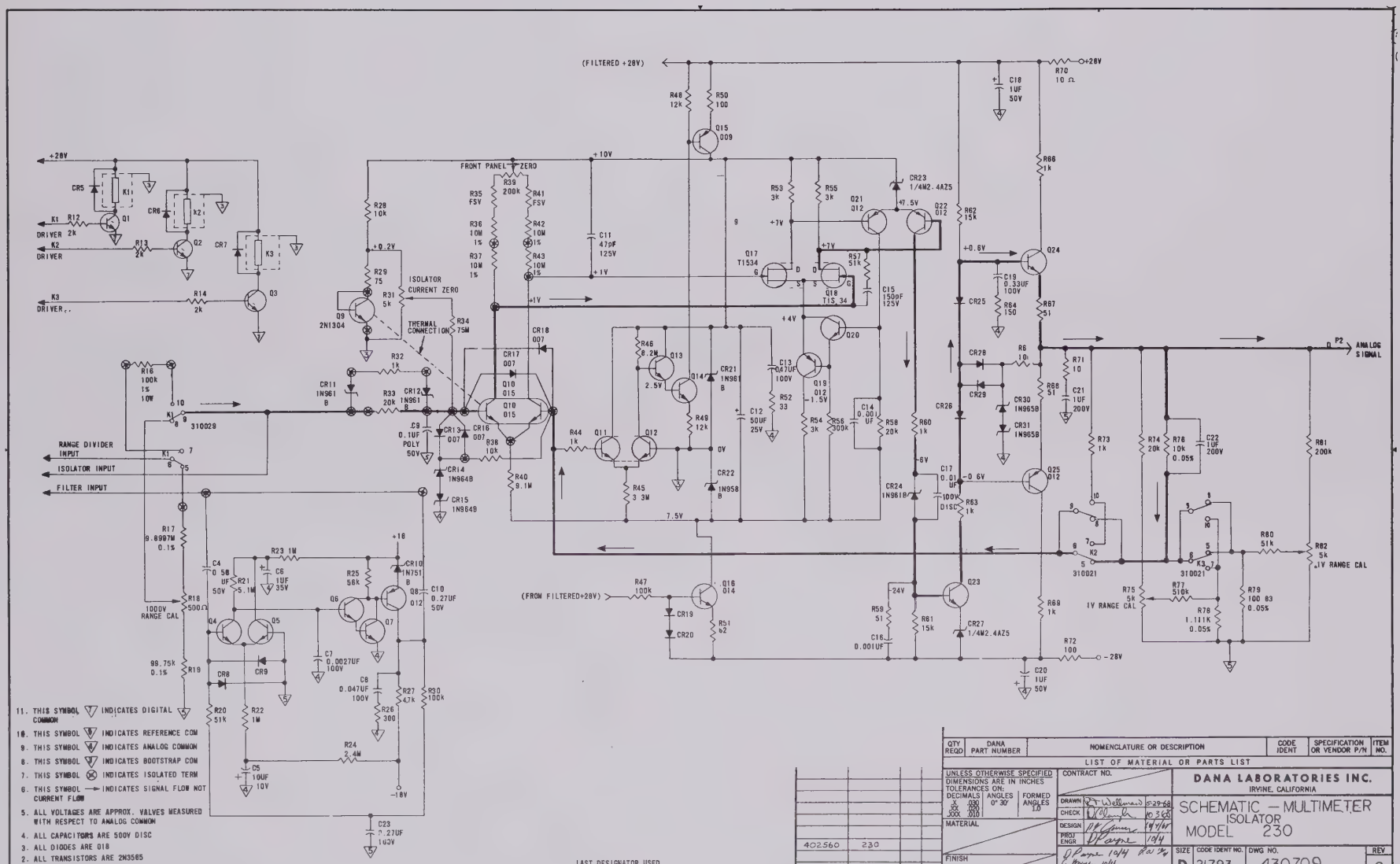
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC - MULTIMETER
MODEL 230

DRAWN		5-29-69	
CHECK		11-3	
DESIGN			
PROJ ENGR			

402560	230		
NEXT ASSY	USED ON	NA	FA
APPLICATION		QTY REQD	

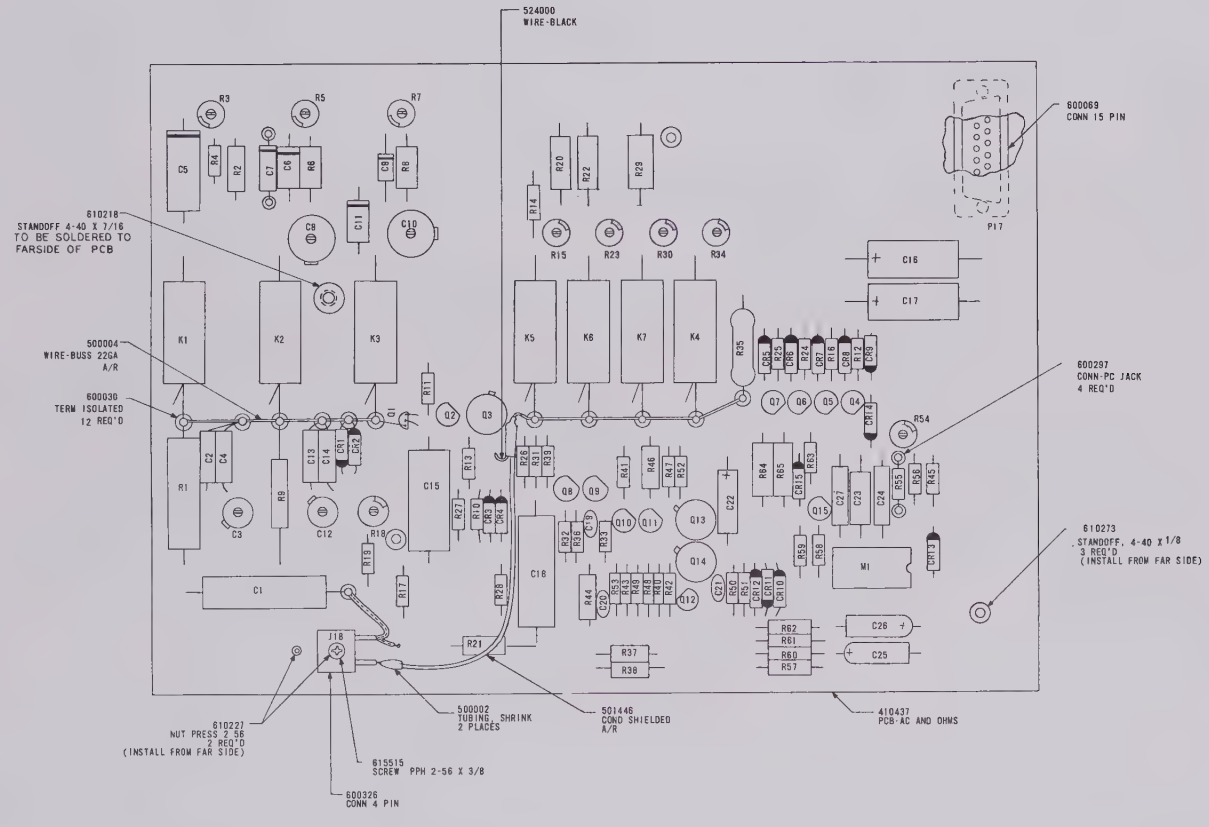
SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	430709	C
SCALE	WT	SHEET 1 OF 2	



QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.

LIST OF MATERIAL OR PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON: DECIMALS .XX ±.030 .XXX ±.010 ANGLES ±30' FORMED ANGLES 1.0	CONTRACT NO.	DANA LABORATORIES INC. IRVINE, CALIFORNIA	
MATERIAL	DRAWN	SCHEMATIC — MULTIMETER ISOLATOR MODEL 230	
FINISH	CHECK		
402560 230	DESIGN		
NEXT ASSY USED ON NA FA	PROJ ENGR	SIZE D CODE IDENT NO. 21793 DWG NO. 430709 REV C	
APPLICATION QTY REQD		SCALE WT SHEET 2 OF 2	



2. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM TO DANA WORKMANSHIP STANDARDS.
1. SCHEMATIC REFERENCE 430829

NOTES: UNLESS OTHERWISE SPECIFIED

402582	230		
NEXT DWG	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON:
DECIMALS: X .030, XX .020, XXX .010
ANGLES: 0° 30' FORMED, 1° 0'
HOLE DIAMETERS: +.004 -.001
MATERIAL
FINISH

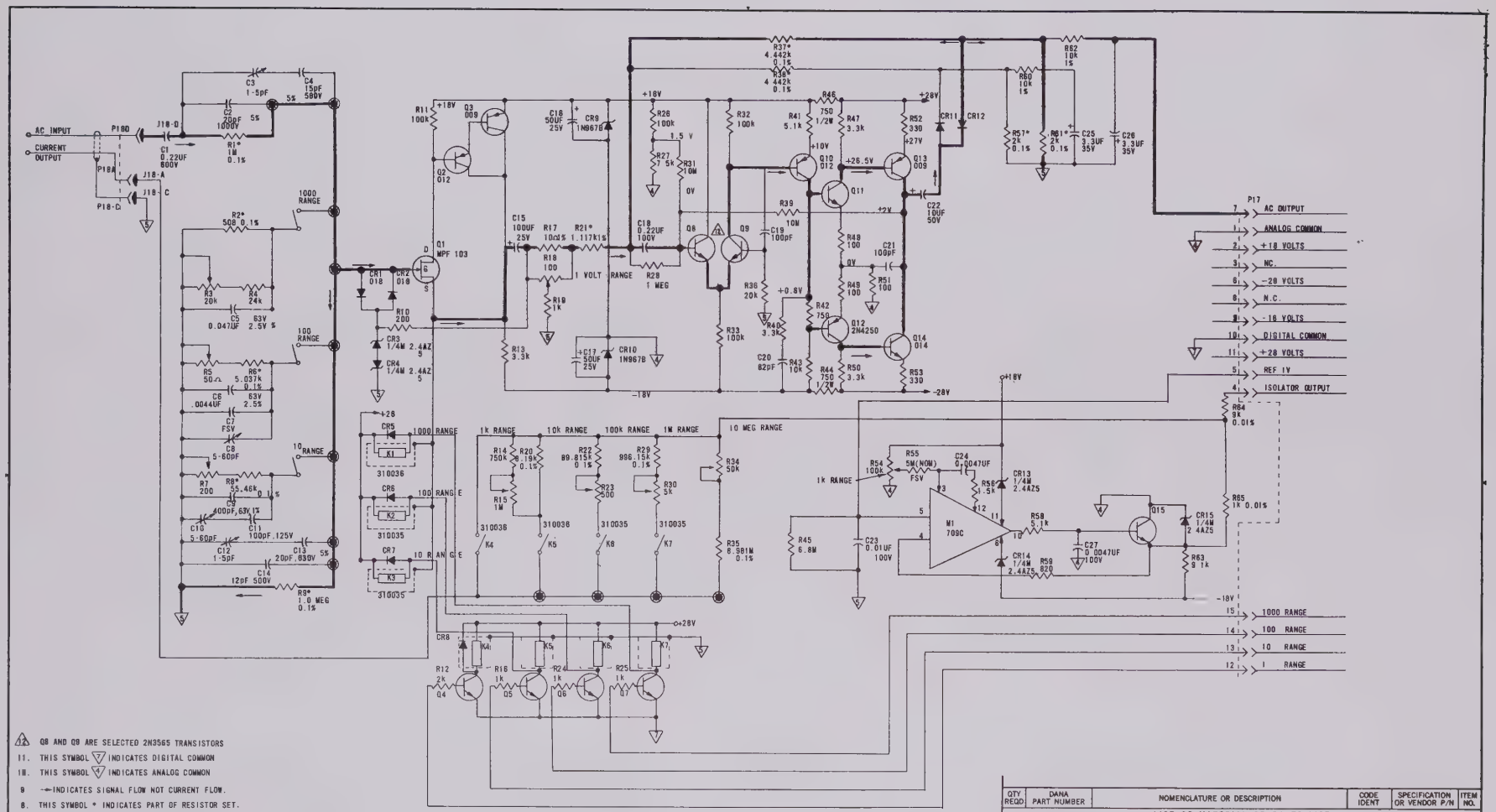
DRAWN	P. HASLAM	8-1-68
CHECK	D. Chmak	10-7-68
DESIGN	W. Lamm	10/4/68
MECH ENGR	J. Wace	10/6
PROJ ENGR	D. Lange	10/4
	D. Lange 10/4	
	B. Mayo 10/4	

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ASSY A.C. & OHMS CONVERTER

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	402581	H

SCALE 2:1 SHEET 1 OF 3



△12 Q8 AND Q9 ARE SELECTED 2N3565 TRANSISTORS

11. THIS SYMBOL ▽ INDICATES DIGITAL COMMON

10. THIS SYMBOL ▽ INDICATES ANALOG COMMON

9 —•— INDICATES SIGNAL FLOW NOT CURRENT FLOW.

8. THIS SYMBOL * INDICATES PART OF RESISTOR SET.

7. THIS SYMBOL ⊗ INDICATES INSOLATED TERMINALS

6. ALL VOLTAGES ARE APPROXIMATE VALUES MEASURED WITH RESPECT TO ANALOG COMMON

5. ALL CAPACITORS TO BE 500V DISC

4. THIS SYMBOL ▽ INDICATES REFERENCE COMMON

3. ALL DIODES TO BE: 018

2. ALL TRANSISTORS TO BE 2N3565

1. ALL RESISTOR VALUES ARE IN OHMS, 1/4W, 5%, CARBON

NOTE: UNLESS OTHERWISE SPECIFIED

LAST DESIGNATORS USED

C27	CR15		K7	Q15	R65

QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.

LIST OF MATERIAL OR PARTS LIST

402581	230	
NEXT ASSY	USED ON	NA FA
APPLICATION		QTY REQD

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON:
DECIMALS | ANGLES | FORMED ANGLES
X .030 | 0° 30' | 1.0
XX .020
XXX .010

MATERIAL

FINISH

CONTRACT NO.

DRAWN	R. Wallman	5-21-68
CHECK	D. Cooper	10 3 68
DESIGN	W. Cannon	10/4/68
PROJ ENGR	D. Payne	10/4
	D. Payne 10/4	6a 10/4/68
	A. Myer 10/4	

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC MULTIMETER
AC AND OHMS CONVERTOR
MODEL 230

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	430829	C

SCALE | WT | SHEET 1 OF 1

PARTS LIST

ASSEMBLY 402487 **Readout Assembly**

A

REF. DESIG.	PART NO.	DESCRIPTION							
CR01	211083	DIODE SILICO	018			1	DANA	211083	
CR02	211083	DIODE SILICO	018			1	DANA	211083	
CR03	211083	DIODE SILICO	018			1	DANA	211083	
CR04	211083	DIODE SILICO	018			1	DANA	211083	
CR05	402467								
CR06	220004	DIODE SILICO ZENER	1N961B			1	MOTOROLA	1N961B	
CR07	220030	DIODE SILICO ZENER	1/4M2.4AZ5				MOTOROLA	1/4M2.4AZ5	
CR08	211083	DIODE SILICO	018			1	DANA	211083	
CR09	211083	DIODE SILICO	018			1	DANA	211083	
CR10	220030	DIODE SILICO ZENER	1/4M2.4AZ5				MOTOROLA	1/4M2.4AZ5	
CR11	211083	DIODE SILICO	018			1	DANA	211083	
CR12	211083	DIODE SILICO	018			1	DANA	211083	
CR13	211083	DIODE SILICO	018			1	DANA	211083	
CR14	211083	DIODE SILICO	018			1	DANA	211083	
CR15	211083	DIODE SILICO	018			1	DANA	211083	
CR16	211083	DIODE SILICO	018			1	DANA	211083	
CR17	211083	DIODE SILICO	018			1	DANA	211083	
C01	110068	CAP ELEC	5 MFD	25 V			DUCATI	5-25	
C02	120174	CAP POLY	.5 MFD	100 V	5%		CDE	WMF6S1	
C03	110069	CAP ELEC	10 MFD	10 V			KEMET	K10W10K	
C04	110043	CAP ELECT	25 MFD	25 V	20%		DUCATI	25-25	
C05	100006	CAP CERM	22 PFD	500 V	10%		AEROVOX	TCD-N750	
C06	101098	CAP CERAM	330 PFD	500 V	10%1		AEROVOX	SCD1X5F	
C07	101145	CAP CERAM	100 PFD	500 V	10%1		AEROVOX	SCD1X5F	
C08	101145	CAP CERAM	100 PFD	500 V	10%1		AEROVOX	SCD1X5F	
C09	101098	CAP CERAM	330 PFD	500 V	10%1		AEROVOX	SCD1X5F	
C10	110047	CAP ELECT	50 MFD	50 V	20%		DUCATI	50-50	
C11	110071	CAP ELECT	.1 MFD	35 V	10%		KEMET	K1W35K	
C12	100006	CAP CERAM	22 PRD	500 V	10%		AEROVOX	TCD-N750	
C13	101642	CAP CERAM	150 PFD	500 V	10%1		AEROVOX	SCD2X5F	
C14	101174	CAP CERAM	.001 MFD	500 V	10%1		AEROVOX	SCD3X5F	
C15	101174	CAP CERAM	.001 MFD	500 V	10%1		AEROVOX	SCD3X5F	
C16	101174	CAP CERAM	.001 MFD	500 V	10%1		AEROVOX	SCD3X5F	
C17	121091	CAP MYLAR	.033 MFD	100 V	10%1		CDE	WMF1533	
C18	100008	CAP CERAM	82 PFD	500 V	10%		AEROVOX	TCD-N750	
C19	110069	CAP ELEC	10 MFD	10 V			KEMET	K10W10K	
C20	110069	CAP ELEC	10 MFD	10 V			KEMET	K10W10K	
C21	121091	CAP MYLAR	.033 MFD	100 V	10%1		CDE	WMF1533	

PARTS LIST

ASSEMBLY 402487 **Readout Assembly**

REF. DESIG.	PART NO.	DESCRIPTION							
C22	101182	CAP	CERAM	47 PFD	500 V	10%1		AEROVOX	TCD-N750
C23	101174	CAP	CERAM	.001 MFD	500 V	10%1		AEROVOX	SCD3X5F
C24	101174	CAP	CERAM	.001 MFD	500 V	10%1		AEROVOX	SCD3X5F
C25	101174	CAP	CERAM	.001 MFD	500 V	10%1		AEROVOX	SCD3X5F
C26	101174	CAP	CERAM	.001 MFD	500 V	10%1		AEROVOX	SCD3X5F
C27	101098	CAP	CERAM	330 PFD	500 V	10%1		AEROVOX	SCD1X5F
C28	101182	CAP	CERAM	47 PFD	500 V	10%1		AEROVOX	TCD-N750
DS01	920116	LAMP	NEON	NE-2H				G E	MPG250-3
DS02	920342	NEON		NE-2H				GE	C2A-M
DS03	920116	LAMP	NEON	NE-2H				G E	MPG250-3
M01	230003	INTEGRATED CIRCUIT MC790						MOTOROLA	MC790P
M02	230003	INTEGRATED CIRCUIT MC790						MOTOROLA	MC790P
M03	230003	INTEGRATED CIRCUIT MC790						MOTOROLA	MC790P
M04	230003	INTEGRATED CIRCUIT MC790						MOTOROLA	MC790P
M05	230003	INTEGRATED CIRCUIT MC790						MOTOROLA	MC790P
M06	230003	INTEGRATED CIRCUIT MC790						MOTOROLA	MC790P
M07	230003	INTEGRATED CIRCUIT MC790						MOTOROLA	MC790P
M08	230003	INTEGRATED CIRCUIT MC790						MOTOROLA	MC790P
M09	230003	INTEGRATED CIRCUIT MC790						MOTOROLA	MC790P
M10	230003	INTEGRATED CIRCUIT MC790						MOTOROLA	MC790P
M11	230000	INTEGRATED CIRCUIT MC724						MOTOROLA	MC724P
M12	230000	INTEGRATED CIRCUIT MC724						MOTOROLA	MC724P
M13	230000	INTEGRATED CIRCUIT MC724						MOTOROLA	MC724P
M14	230015	INTEGRATED CIRCUIT MC723P						MOTOROLA	MC723P
M15	230000	INTEGRATED CIRCUIT MC724						MOTOROLA	MC724P
M16	230000	INTEGRATED CIRCUIT MC724						MOTOROLA	MC724P
M17	230000	INTEGRATED CIRCUIT MC724						MOTOROLA	MC724P
M18	230000	INTEGRATED CIRCUIT MC724						MOTOROLA	MC724P
M19	230006	INTEGRATED CIRCUIT MC799P						MOTOROLA	MC799P
M20	230000	INTEGRATED CIRCUIT MC724						MOTOROLA	MC724P
M21	230014	INTEGRATED CIRCUIT UL9960						FAIRCHILD	UL9960
M22	230014	INTEGRATED CIRCUIT UL9960						FAIRCHILD	UL9960
M23	230014	INTEGRATED CIRCUIT UL9960						FAIRCHILD	UL9960
M24	230014	INTEGRATED CIRCUIT UL9960						FAIRCHILD	UL9960
Q01	201084	TRANS GERMAN PNP		2N1304			1	TI	2N1304
Q02	200037	TRANS SILICO NPN		2N3646				FAIRCHILD	2N3646
Q03	200049	TRANS		2N3417				GE	2N3417
Q04	200040	TRANS SILICO NPN		016				DANA	200040

PARTS LIST

ASSEMBLY 402487 Readout Assembly

A

REF. DESIG.	PART NO.	DESCRIPTION		
Q05	200040	TRANS SILICO NPN	016	DANA 200040
Q06	200043	TRANS SILICO NPN	2N3565	FAIRCHILD 2N3565
Q07	200044	TRANS SILICO NPN DUAL	FSV	DANA 200044
Q08	200044	TRANS SILICO NPN DUAL	FSV	DANA 200044
Q09	200052	TRANS SILICO PNP	009	DANA 200052
Q10	200044	TRANS SILICO NPN DUAL	FSV	DANA 200044
Q11	200044	TRANS SILICO NPN DUAL	FSV	DANA 200044
Q12	200044	TRANS SILICO NPN DUAL	FSV	DANA 200044
Q13	200044	TRANS SILICO NPN DUAL	FSV	DANA 200044
Q14	200052	TRANS SILICO PNP	009	DANA 200052
Q15	200043	TRANS SILICO NPN	2N3565	FAIRCHILD 2N3565
Q16	200044	TRANS SILICO NPN DUAL	FSV	DANA 200044
Q17	200044	TRANS SILICO NPN DUAL	FSV	DANA 200044
Q18	200043	TRANS SILICO NPN	2N3565	FAIRCHILD 2N3565
Q19	200052	TRANS SILICO PNP	009	DANA 200052
Q20	200035	TRANS SILICO NPN	014	DANA 200035
Q21	200022	TRANS SILICO PNP	012	DANA 200022
Q22	200043	TRANS SILICO NPN	2N3565	FAIRCHILD 2N3565
Q23	200043	TRANS SILICO NPN	2N3565	FAIRCHILD 2N3565
Q24	200043	TRANS SILICO NPN	2N3565	FAIRCHILD 2N3565
Q25	200035	TRANS SILICO NPN	014	DANA 200035
Q26	200043	TRANS SILICO NPN	2N3565	FAIRCHILD 2N3565
Q27	200043	TRANS SILICO NPN	2N3565	FAIRCHILD 2N3565
Q28	200040	TRANS SILICO NPN	016	DANA 200040
Q29	200043	TRANS SILICO NPN	2N3565	FAIRCHILD 2N3565
Q30	200043	TRANS SILICO NPN	2N3565	FAIRCHILD 2N3565
Q31	200022	TRANS SILICO PNP	012	DANA 200022
Q32	200043	TRANS SILICO NPN	2N3565	FAIRCHILD 2N3565
Q33	200035	TRANS SILICO NPN	014	DANA 200035
Q34	200037	TRANS SILICO NPN	2N3646	FAIRCHILD 2N3646
Q35	200075	TRANS	2N4870	MOTOROLA 2N4870
Q36	200035	TRANS SILICO NPN	014	DANA 200035
Q37	200035	TRANS SILICO NPN	014	DANA 200035
Q38	200037	TRANS SILICO NPN	2N3646	FAIRCHILD 2N3646
Q39	200035	TRANS SILICO NPN	014	DANA 200035
Q40	200035	TRANS SILICO NPN	014	DANA 200035
Q41	200035	TRANS SILICO NPN	014	DANA 200035
Q42	200079	TRANS	021	DANA 200079

PARTS LIST

ASSEMBLY 402487 **Readout Assembly** A

REF. DESIG.	PART NO.	DESCRIPTION						
Q43	200035	TRANS SILICO NPN	014				DANA	200035
Q44	200037	TRANS SILICO NPN	2N3646				FAIRCHILD	2N3646
Q45	200035	TRANS SILICO NPN	014				DANA	200035
Q46	200035	TRANS SILICO NPN	014				DANA	200035
Q47	200035	TRANS SILICO NPN	014				DANA	200035
Q48	200035	TRANS SILICO NPN	014				DANA	200035
R01	040101	RES VARI	50 OHM				CTS	
R02	040086	RES VARI	2 K	10%			BECKMAN	62PR2K
R03	020241	RES WW	10 K	.05%	1/8 W		JORDAN	J-11
R04	020391	RES WW	11.4 K	.5%	1/8 W		JORDAN	J11
R05	020241	RES WW	10 K	.05%	1/8 W		JORDAN	J-11
R06	000183	RES CARBON	18 K	5%	1/4 W1		OHMITE	RC07GF183J
R07	000202	RES CARBON	2 K	5%	1/4 W1		OHMITE	RC07GF202J
R10	000102	RES CARBON	1 K	5%	1/4 W1		OHMITE	RC07GF102J
R11	040087	RES VARI	10 K	10%	1/4 W		BECKMAN	62PR10K
R12	000202	RES CARBON	2 K	5%	1/4 W1		OHMITE	RC07GF202J
R13	000333	RES CARBON	33 K	5%	1/4 W		OHMITE	RC07GF333J
R14	010149	RES METAL	499 OHM	1%	1/4 W		ELECTRA	RN60D4990F
R15	040098	RES VARI	20 K	10%			BECKMAN	62PR20K
R16	402467							
R17	000103	RES CARBON	10 K	5%	1/4 W1		OHMITE	RC07GF103J
R18	020390	RES WW	1 K	.05%	1/8 W		JORDAN	J11
R19	010038	RES METAL	422 K	1%	1/4 W		ELECTRA	RN60D4223F
R20	040088	RES VARI	100 K	10%			BECKMAN	62PR100K
R21	010038	RES METAL	422 K	1%	1/4 W		ELECTRA	RN60D4223F
R22	000184	RES CARBON	180 K	5%	1/4 W		OHMITE	RC07GF184J
R23	000184	RES CARBON	180 K	5%	1/4 W		OHMITE	RC07GF184J
R24	010038	RES METAL	422 K	1%	1/4 W		ELECTRA	RN60D4223F
R25	040088	RES VARI	100 K	10%			BECKMAN	62PR100K
R26	010038	RES METAL	422 K	1%	1/4 W		ELECTRA	RN60D4223F
R27	000363	RES CARBON	36 K	5%	1/4 W1		OHMITE	RC07GF363J
R28	000183	RES CARBON	18 K	5%	1/4 W1		OHMITE	RC07GF183J
R29	402467							
R30	010063	RES METAL	3.92 K	1%	1/4 W		ELECTRA	RN60D3921F
R31	000681	RES CARBON	680 OHM	5%	1/4 W1		OHMITE	RC07GF681J
R32	000512	RES CARBON	5.1 K	5%	1/4 W1		OHMITE	RC07GF512J
R33	000512	RES CARBON	5.1 K	5%	1/4 W1		OHMITE	RC07GF512J

PARTS LIST

ASSEMBLY 402487 **Readout Assembly** A

REF. DESIG.	PART NO.	DESCRIPTION							
R34	001737	RES	FSV			5%	1/4 W	DANA	001737
R35	020468	RES	WW	6	K	.5%		JORDAN	J11
R36	040086	RES	VARI	2	K	10%		BECKMAN	62PR2K
R37	020389	RES	WW	5	K	.5%	1/8 W	JORDAN	J11
R38	000332	RES	CARBON	3.3	K	5%	1/4 W1	OHMITE	RC07GF332J
R39	000223	RES	CARBON	22	K	5%	1/4 W	OHMITE	RC07GF223J
R40	000393	RES	CARBON	39	K	5%	1/4 W	OHMITE	RC07GF393J
R41	000244	RES	CARBON	240	K	5%	1/4 W1	OHMITE	RC07GF244J
R42	000272	RES	CARBON	2.7	K	5%	1/4 W	OHMITE	RC07GF272J
R43	000163	RES	CARBON	16	K	5%	1/4 W1	OHMITE	RC07GF163J
R44	000203	RES	CARBON	20	K	5%	1/4 W1	OHMITE	RC07GF203J
R45	000910	RES	CARBON	91	OHM	5%	1/4 W1	OHMITE	RC07GF910J
R46	000910	RES	CARBON	91	OHM	5%	1/4 W1	OHMITE	RC07GF910J
R47	000102	RES	CARBON	1	K	5%	1/4 W1	OHMITE	RC07GF102J
R48	000154	RES	CARBON	150	K	5%	1/4 W1	OHMITE	RC07GF154J
R49	000821	RES	CARBON	820	OHM	5%	1/4 W	OHMITE	RC07GF821J
R50	000391	RES	CARBON	390	OHM	5%	1/4 W	OHMITE	RC07GF391J
R51	000472	RES	CARBON	4.7	K	5%	1/4 W1	OHMITE	RC07GF472J
R53	000391	RES	CARBON	390	OHM	5%	1/4 W	OHMITE	RC07GF391J
R54	000393	RES	CARBON	39	K	5%	1/4 W	OHMITE	RC07GF393J
R55	040053	RES	VARI	5	K	10%	1.5 W	CTS	110
R56	010137	RES	METAL	100	OHM	1%	1/4 W	ELECTRA	RN60D1000F
R57	020406	RES	WW	4.893	K	.05%	1/8 W	JORDAN	J11
R58	020241	RES	WW	10	K	.05%	1/8 W	JORDAN	J-11
R59	020241	RES	WW	10	K	.05%	1/8 W	JORDAN	J-11
R60	000200	RES	CARBON	20	OHM	5%	1/4 W	OHMITE	RC07GF200J
R61	000201	RES	CARBON	200	OHM	5%	1/4 W1	OHMITE	RC07GF201J
R62	000103	RES	CARBON	10	K	5%	1/4 W1	OHMITE	RC07GF103J
R63	040087	RES	VARI	10	K	10%	1/4 W	BECKMAN	62PR10K
R64	000104	RES	CARBON	100	K	5%	1/4 W1	OHMITE	RC07GF104J
R65	000152	RES	CARBON	1.5	K	5%	1/4 W1	OHMITE	RC07GF152J
R66	000152	RES	CARBON	1.5	K	5%	1/4 W1	OHMITE	RC07GF152J
R67	000472	RES	CARBON	4.7	K	5%	1/4 W1	OHMITE	RC07GF472J
R68	010013	RES	METAL	60.4	K	1%	1/4 W	ELECTRA	RN60C6042F
R69	010059	RES	METAL	20	K	1%	1/4 W	ELECTRA	RN60D2002F
R70	040097	RES	VARI	5	K	10%		BECKMAN	62PR5K
R71	010059	RES	METAL	20	K	1%	1/4 W	ELECTRA	RN60D2002F
R72	010078	RES	METAL	86.6	K	1%	1/4 W	ELECTRA	RN60B8662F

PARTS LIST

ASSEMBLY 402487 **Readout Assembly** A

REF. DESIG.	PART NO.	DESCRIPTION							
R73	000563	RES	CARBON	56 K	5%	1/4 W		OHMITE	RC07GF563J
R74	000104	RES	CARBON	100 K	5%	1/4 W1		OHMITE	RC07GF104J
R75	000183	RES	CARBON	18 K	5%	1/4 W1		OHMITE	RC07GF183J
R76	000202	RES	CARBON	2 K	5%	1/4 W1		OHMITE	RC07GF202J
R77	000102	RES	CARBON	1 K	5%	1/4 W1		OHMITE	RC07GF102J
R78	000512	RES	CARBON	5.1 K	5%	1/4 W1		OHMITE	RC07GF512J
R79	000302	RES	CARBON	3 K	5%	1/4 W1		OHMITE	RC07GF302J
R80	000102	RES	CARBON	1 K	5%	1/4 W1		OHMITE	RC07GF102J
R81	000221	RES	CARBON	220 OHM	5%	1/4 W1		OHMITE	RC07GF221J
R82	000273	RES	CARBON	27 K	5%	1/4 W1		OHMITE	RC07GF273J
R83	000103	RES	CARBON	10 K	5%	1/4 W1		OHMITE	RC07GF103J
R84	000223	RES	CARBON	22 K	5%	1/4 W		OHMITE	RC07GF223J
R85	000511	RES	CARBON	510 OHM	5%	1/4 W1		OHMITE	RC07GF511J
R86	000101	RES	CARBON	100 OHM	5%	1/4 W1		OHMITE	RC07GF101J
R87	001745	RES	CARBON	56 K	5%	1/2 W		OHMITE	RC20GF563J
R88	001744	RES	CARBON	27 K	5%	1/2 W		OHMITE	RC20GF273J
R89	000302	RES	CARBON	3 K	5%	1/4 W1		OHMITE	RC07GF302J
R90	000302	RES	CARBON	3 K	5%	1/4 W1		OHMITE	RC07GF302J
R91	000202	RES	CARBON	2 K	5%	1/4 W1		OHMITE	RC07GF202J
R92	000102	RES	CARBON	1 K	5%	1/4 W1		OHMITE	RC07GF102J
R93	001744	RES	CARBON	27 K	5%	1/2 W		OHMITE	RC20GF273J
R94	001745	RES	CARBON	56 K	5%	1/2 W		OHMITE	RC20GF563J
R95	000102	RES	CARBON	1 K	5%	1/4 W1		OHMITE	RC07GF102J
R96	000102	RES	CARBON	1 K	5%	1/4 W1		OHMITE	RC07GF102J
R97	000623	RES	CARBON	62 K	5%	1/4 W1		OHMITE	RC07GF623J
R98	000302	RES	CARBON	3 K	5%	1/4 W1		OHMITE	RC07GF302J
R99	000223	RES	CARBON	22 K	5%	1/4 W		OHMITE	RC07GF223J
R100	001744	RES	CARBON	27 K	5%	1/2 W		OHMITE	RC20GF273J
R101	001745	RES	CARBON	56 K	5%	1/2 W		OHMITE	RC20GF563J
R102	000471	RES	CARBON	470 OHM	5%	1/4 W1		OHMITE	RC07GF471J
R103	000302	RES	CARBON	3 K	5%	1/4 W1		OHMITE	RC07GF302J
R104	000102	RES	CARBON	1 K	5%	1/4 W1		OHMITE	RC07GF102J
R105	000102	RES	CARBON	1 K	5%	1/4 W1		OHMITE	RC07GF102J
R106	001744	RES	CARBON	27 K	5%	1/2 W		OHMITE	RC20GF273J
R107	001745	RES	CARBON	56 K	5%	1/2 W		OHMITE	RC20GF563J
R108	000102	RES	CARBON	1 K	5%	1/4 W1		OHMITE	RC07GF102J
R109	000623	RES	CARBON	62 K	5%	1/4 W1		OHMITE	RC07GF623J

PARTS LIST

ASSEMBLY 402487 **Readout Assembly** A

REF. DESIG.	PART NO.	DESCRIPTION							
R110	000302	RES	CARBON	3 K	5%	1/4 W1	OHMITE	RC07GF302J	
R111	001745	RES	CARBON	56 K	5%	1/2 W	OHMITE	RC20GF563J	
R112	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J	
R113	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J	
R114	001744	RES	CARBON	27 K	5%	1/2 W	OHMITE	RC20GF273J	
R115	000100	RES	CARBON	10 OHM	5%	1/4 W1	OHMITE	RC07GF100J	
R116	000202	RES	CARBON	2 K	5%	1/4 W1	OHMITE	RC07GF202J	

PARTS LIST

ASSEMBLY 402498 **PCB Assembly- Power Supply 4470** A

REF. DESIG.	PART NO.	DESCRIPTION		
CR01	210004	DIODE SILICO SD4	DIODES IN SD4	
CR02	210004	DIODE SILICO SD4	DIODES IN SD4	
CR03	210004	DIODE SILICO SD4	DIODES IN SD4	
CR04	210004	DIODE SILICO SD4	DIODES IN SD4	
CR05	210004	DIODE SILICO SD4	DIODES IN SD4	
CR06	210004	DIODE SILICO SD4	DIODES IN SD4	
CR07	210004	DIODE SILICO SD4	DIODES IN SD4	
CR08	210004	DIODE SILICO SD4	DIODES IN SD4	
CR09	210004	DIODE SILICO SD4	DIODES IN SD4	
CR10	210004	DIODE SILICO SD4	DIODES IN SD4	
CR11	221177	DIODE SILICO ZENER 1/4 W1	MOTOROLA	M.2.4A25
CR12	220015	DIODE SILICO ZENER 1N967B	MOTOROLA	1N967B
CR13	220015	DIODE SILICO ZENER 1N967B	MOTOROLA	1N967B
C01	121088	CAP MYLAR .01 MFD 100 V 10%	CDE	WMF1S1
C02	110067	CAP ELECT 2000 MFD 35 V 20%	DUCATI	2000-35
C03	110067	CAP ELECT 2000 MFD 35 V 20%	DUCATI	2000-35
C04	121088	CAP MYLAR .01 MFD 100 V 10%	CDE	WMF1S1
C05	110085	CAP ELECT 2000 MFD 10 V 20%	DUCATI	2000-10
C06	110083	CAP ELECT 100 MFD 10 V 20%	DUCATI	100-10
C07	120072	CAP MYLAR .01 MFD 600 V 10%	CDE	WMF651
C08	110065	CAP ELECT 20 MFD 350 V 20%	DUCATI	20-350
C09	110066	CAP ELECT 15 MFD 200 V 20%	DUCATI	15-200
C10	110083	CAP ELECT 100 MFD 10 V 20%	DUCATI	100-10
C11	121088	CAP MYLAR .01 MFD 100 V 10%	CDE	WMF1S1
C12	110043	CAP ELECT 25 MFD 25 V 20%	DUCATI	25-25
C13	110043	CAP ELECT 25 MFD 25 V 20%	DUCATI	25-25
C14	101174	CAP CERAM .001 MFD 500 V 10%1	AEROVOX	SCD3X5F
C15	101174	CAP CERAM .001 MFD 500 V 10%1	AEROVOX	SCD3X5F
C16	110077	CAP ELECT 1000 UF 15/16 V 20%	CDE	BR1000-15
Q01	200043	TRANS SILICO NPN 2N3565	FAIRCHILD	2N3565
Q02	200035	TRANS SILICO NPN 014	DANA	200035
Q03	200030	TRANS SILICO NPN 40250	RCA	40250
Q04	200035	TRANS SILICO NPN 014	DANA	200035
Q05	200011	TRANS SILICO PNP 009	DANA	200011
R01	000241	RES CARBON 240 OHM 5% 1/4 W1	OHMITE	RC07GF241J
R02	000241	RES CARBON 240 OHM 5% 1/4 W1	OHMITE	RC07GF241J
R03	030014	RES CARBON 220 K 5% 1 W	OHMITE	RC32GF224J
R04	000751	RES CARBON 750 OHM 5% 1/4 W1	OHMITE	RC07GF751J

PARTS LIST

ASSEMBLY 402498 **PCB Assembly - Power Supply 4470**

A

REF. DESIG.	PART NO.	DESCRIPTION							
R05	000751	RES	CARBON	750	OHM	5%	1/4 W1	OHMITE	RC07GF751J
R06	000224	RES	CARBON	220	K	5%	1/4 W1	OHMITE	RC07GF224J
R07	000202	RES	CARBON	2	K	5%	1/4 W1	OHMITE	RC07GF202J
R08	030007	RES	CARBON	150	OHM	5%	3 W	OHMITE	4396
R09	000151	RES	CARBON	150	OHM	5%	1/4 W1	OHMITE	RC07GF151J
R10	000151	RES	CARBON	150	OHM	5%	1/4 W1	OHMITE	RC07GF151J
R11	000202	RES	CARBON	2	K	5%	1/4 W1	OHMITE	RC07GF202J
R12	030007	RES	CARBON	150	OHM	5%	3 W	OHMITE	4396
R13	040063	RES	VARI	500	OHM	10%	1.5 W	CTS	110
R14	000511	RES	CARBON	510	OHM	5%	1/4 W1	OHMITE	RC07GF511J

PARTS LIST

ASSEMBLY 402489 **PCB Assembly - Power Supply, 4430** A

REF. DESIG.	PART NO.	DESCRIPTION
CR01	210004	DIODE SILICO SD4 DIODES IN SD4
CR02	210004	DIODE SILICO SD4 DIODES IN SD4
CR03	210004	DIODE SILICO SD4 DIODES IN SD4
CR04	210004	DIODE SILICO SD4 DIODES IN SD4
CR05	210004	DIODE SILICO SD4 DIODES IN SD4
CR06	210004	DIODE SILICO SD4 DIODES IN SD4
CR07	210004	DIODE SILICO SD4 DIODES IN SD4
CR08	210004	DIODE SILICO SD4 DIODES IN SD4
CR09	210004	DIODE SILICO SD4 DIODES IN SD4
CR10	210004	DIODE SILICO SD4 DIODES IN SD4
CR11	221177	DIODE SILICO ZENER 1/4 W1 MOTOROLA M.2.4A25
CR12	220015	DIODE SILICO ZENER 1N967B MOTOROLA 1N967B
CR13	220015	DIODE SILICO ZENER 1N967B MOTOROLA 1N967B
C01	121088	CAP MYLAR .01 MFD 100 V 10% CDE WMF1S1
C02	110067	CAP ELECT 2000 MFD 35 V 20% DUCATI 2000-35
C03	110067	CAP ELECT 2000 MFD 35 V 20% DUCATI 2000-35
C04	121088	CAP MYLAR .01 MFD 100 V 10% CDE WMF1S1
C05	110085	CAP ELECT 2000 MFD 10 V 20% DUCATI 2000-10
C06	110083	CAP ELECT 100 MFD 10 V 20% DUCATI 100-10
C07	120072	CAP MYLAR .01 MFD 600 V 10% CDE WMF651
C08	110065	CAP ELECT 20 MFD 350 V 20% DUCATI 20-350
C09	110066	CAP ELECT 15 MFD 200 V 20% DUCATI 15-200
C10	110083	CAP ELECT 100 MFD 10 V 20% DUCATI 100-10
C11	121088	CAP MYLAR .01 MFD 100 V 10% CDE WMF1S1
C12	110043	CAP ELECT 25 MFD 25 V 20% DUCATI 25-25
C13	110043	CAP ELECT 25 MFD 25 V 20% DUCATI 25-25
C14	101174	CAP CERAM .001 MFD 500 V 10%1 AEROVOX SCD3X5F
C15	101174	CAP CERAM .001 MFD 500 V 10%1 AEROVOX SCD3X5F
C16	110077	CAP ELECT 1000 UF 15/16 V 20% CDE BR1000-15
Q01	200043	TRANS SILICO NPN 2N3565 FAIRCHILD 2N3565
Q02	200035	TRANS SILICO NPN 014 DANA 200035
Q03	200030	TRANS SILICO NPN 40250 RCA 40250
Q04	200035	TRANS SILICO NPN 014 DANA 200035
Q05	200011	TRANS SILICO PNP 009 DANA 200011
R01	000241	RES CARBON 240 OHM 5% 1/4 W1 OHMITE RC07GF241J
R02	000241	RES CARBON 240 OHM 5% 1/4 W1 OHMITE RC07GF241J
R03	030014	RES CARBON 220 K 5% 1 W OHMITE RC32GF224J
R04	000751	RES CARBON 750 OHM 5% 1/4 W1 OHMITE RC07GF751J

PARTS LIST

ASSEMBLY 402489 **PCB Assembly - Power Supply, 4430**

A

REF. DESIG.	PART NO.	DESCRIPTION							
R05	000751	RES	CARBON	750	OHM	5%	1/4 W1	OHMITE	RC07GF751J
R06	000224	RES	CARBON	220	K	5%	1/4 W1	OHMITE	RC07GF224J
R07	000202	RES	CARBON	2	K	5%	1/4 W1	OHMITE	RC07GF202J
R08	030007	RES	CARBON	150	OHM	5%	3 W	OHMITE	4396
R09	000151	RES	CARBON	150	OHM	5%	1/4 W1	OHMITE	RC07GF151J
R10	000151	RES	CARBON	150	OHM	5%	1/4 W1	OHMITE	RC07GF151J
R11	000202	RES	CARBON	2	K	5%	1/4 W1	OHMITE	RC07GF202J
R12	030007	RES	CARBON	150	OHM	5%	3 W	OHMITE	4396
R13	040063	RES	VARI	500	OHM	10%	1.5 W	CTS	110
R14	000511	RES	CARBON	510	OHM	5%	1/4 W1	OHMITE	RC07GF511J

SECTION 7

BCD OUTPUT OPTION

Model 4432

7.0 GENERAL

7.1. The Dana Model 4432 is a standard Model 4430 DMM with the added capability of providing a BCD output of function, range, and display data for a printer or other digital recording device. The Model 4432 is compatible with all of the accessories available for the 4400 series DMM's, such as the accessory modules 210, 212, 220 and 230.

7.2. The 4432 produces an 8421 positive true, voltage level output to a 50-pin connector at the rear of the instrument. The voltage levels produce a binary code for use by the printer and indicate the most recent measurement by the DMM. The BCD code, logic levels and pin connectors are compatible with commonly available printers such as the HP-562A and the HP-5050A.

7.3. Physically, the output circuitry is located on a printed circuit board (designated Buffer) mounted directly above the readout section of the DMM. Interconnecting cables from the readout circuitry to the buffer and from the buffer to the output connector are shown in figure 7.7. The output data, with the exception of range, is generated by transistor switches (see figure 7.1). The range data is generated by a transistor-driven diode matrix. All outputs are approximately +7 volts through 5.6K ohms when true and no greater than +1 volt when false. Voltage for the output option is taken internally from the DMM power supply.

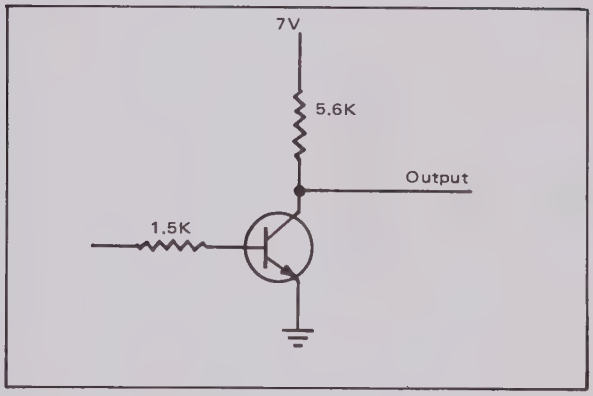


Figure 7.1. Typical Output Circuit

7.4. Since the BCD output circuitry is connected directly to the voltmeter measuring circuits, either the recording device should be isolated from ground or the input signal should be floating to prevent measurement errors due to ground loops.

7.5 OPERATION

7.6. The function and range are selected at the front panel of the DMM (auto range is not used with the BCD output). The BCD data is held continuously until an internal or external command

indicates a new reading.

7.7 EXTERNAL COMMAND

7.8. By placing the DMM in Hold, the DMM takes a new reading only when an external command pulse is received through pin 45 on the BCD output connector. The external command pulse is a +7 volt pulse with a duration greater than .02 milliseconds and less than 5 milliseconds. Rise time must be less than 1 microsecond (see figure 7.2).

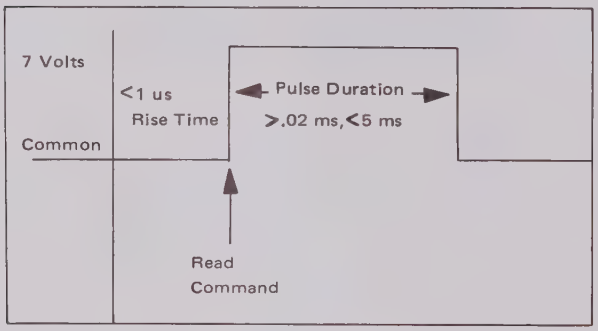


Figure 7.2. External Command

7.9 DELAYS

7.10. Since no time delays are provided in the instrument, delays for settling time must be provided externally to achieve required accuracy levels (see Timing Information, Paragraph 7.26).

7.11 PRINT COMMAND OUTPUT

7.12. The print command is a positive pulse appearing at pin 48 of J11 and generated within the DMM during the read cycle. At the completion of the cycle, the pulse drops to .1 volt, commanding the printer to record all the data at the output connector J11. The print command pulse is +7 volts with a duration of 18 milliseconds or less (the duration of the pulse is dependent on the length of the DMM read cycle). The pulse drops to .1 volt in less than 5 microseconds to command the printer (see figure 7.3).

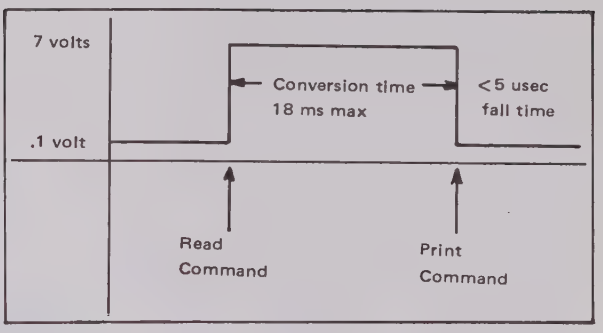


Figure 7.3. Print Command

7.13 BCD CODING

7.14. The coding of DMM digital output is positive true 8421. In the tables below, the 1's represent true or +7 volts and 0's represent false or less than 1 volt.

Digits	8	4	2	1
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1

Function	8	4	2	1
AC	0	0	1	1
Ohms	0	0	0	1
+ Polarity	1	0	1	0
- Polarity	1	0	1	1

Range	8	4	2	1
10,000	0	0	0	0
1,000	0	0	0	1
100	0	0	1	0
10	0	0	1	1
1	0	1	0	0
.1	0	1	0	1

7.15 PIN ASSIGNMENTS

7.16. The locations for the BCD output are shown below. All lines are referenced to pin 24 (common).

7.17 OUTPUT CONNECTOR J11

PIN		PIN	
1	Range (1)	26	Range (4)
2	Range (2)	27	Range (8)
3	Function (1)	28	Function (4)
4	Function (2)	29	Function (8)
5	Ones (1)	30	Ones (4)
6	Ones (2)	31	Ones (8)
7	Tens (1)	32	Tens (4)
8	Tens (2)	33	Tens (8)
9	Hundreds (1)	34	Hundreds (4)
10	Hundreds (2)	35	Hundreds (8)
11	Thousands (1)	36	Thousands (4)
12	Thousands (2)	37	Thousands
13	Ten Thousands (1)	38	Ten Thousands (4)
14	Ten Thousands (2)	39	Ten Thousands (8)
15		40	
16		41	
17	Overload (false during overload condition)	42	
18		43	
19		44	
20		45	Read Command Input
21		46	
22		47	
23		48	Print Command Signal
24	Common, "o" reference	49	
25	+7 volts, "1" reference	50	

MATING CONNECTOR: 50 Pin amphenol blue ribbon 57-30500.

7.18 DANA 4432 OUTPUT/PRINTER INTERFACE.

4432 Option	Logic Type	HP562A Option	HP5050A Option	CMC410A Option
(4432)	1-2-4-8 +7V=true	22	01	4a*

*Special Cable Required.

7.19 HEWLETT PACKARD 562A AND 5050A

Interfacing. The Dana 4432 interfaces directly with the Hewlett-Packard 562A or 5050A printers, using the standard HP interconnecting cable. This cable is a 50-wire, one-to-one cable connecting two 50-pin Amphenol blue ribbon connectors (Amphenol No. 57-30500.) The only additional interfacing is the connection of two lines from the read command source. These lines are brought into the cable and connected to pins 24 and 45. (Refer to figure 7.4.)

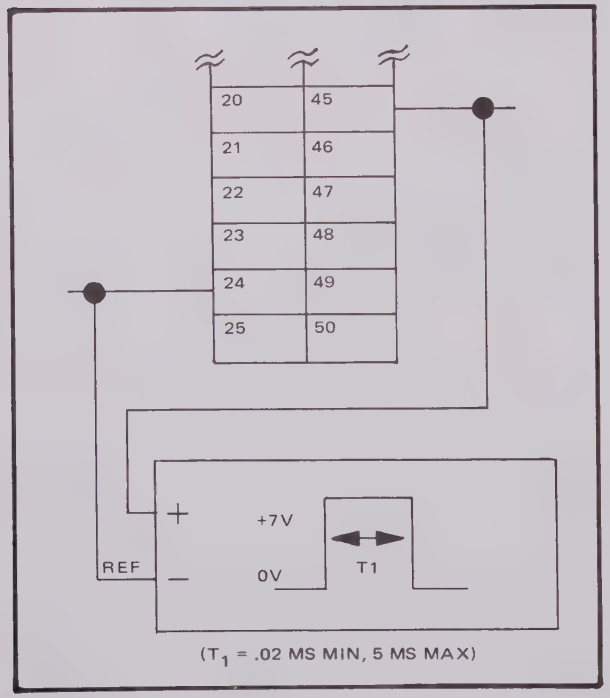


Figure 7.4. Read Command

7.20 An external supply or an npn switch between pins 24 and 25 can be used (refer to figure 7.5).

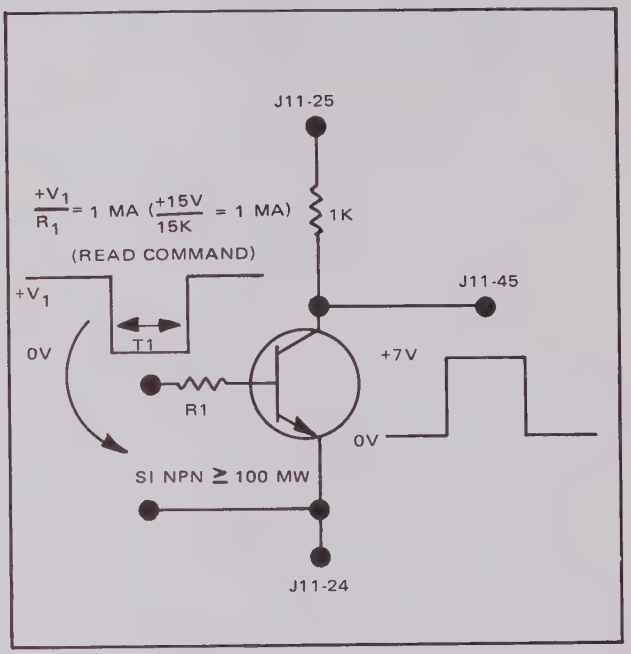


Figure 7.5. Read Command Switch

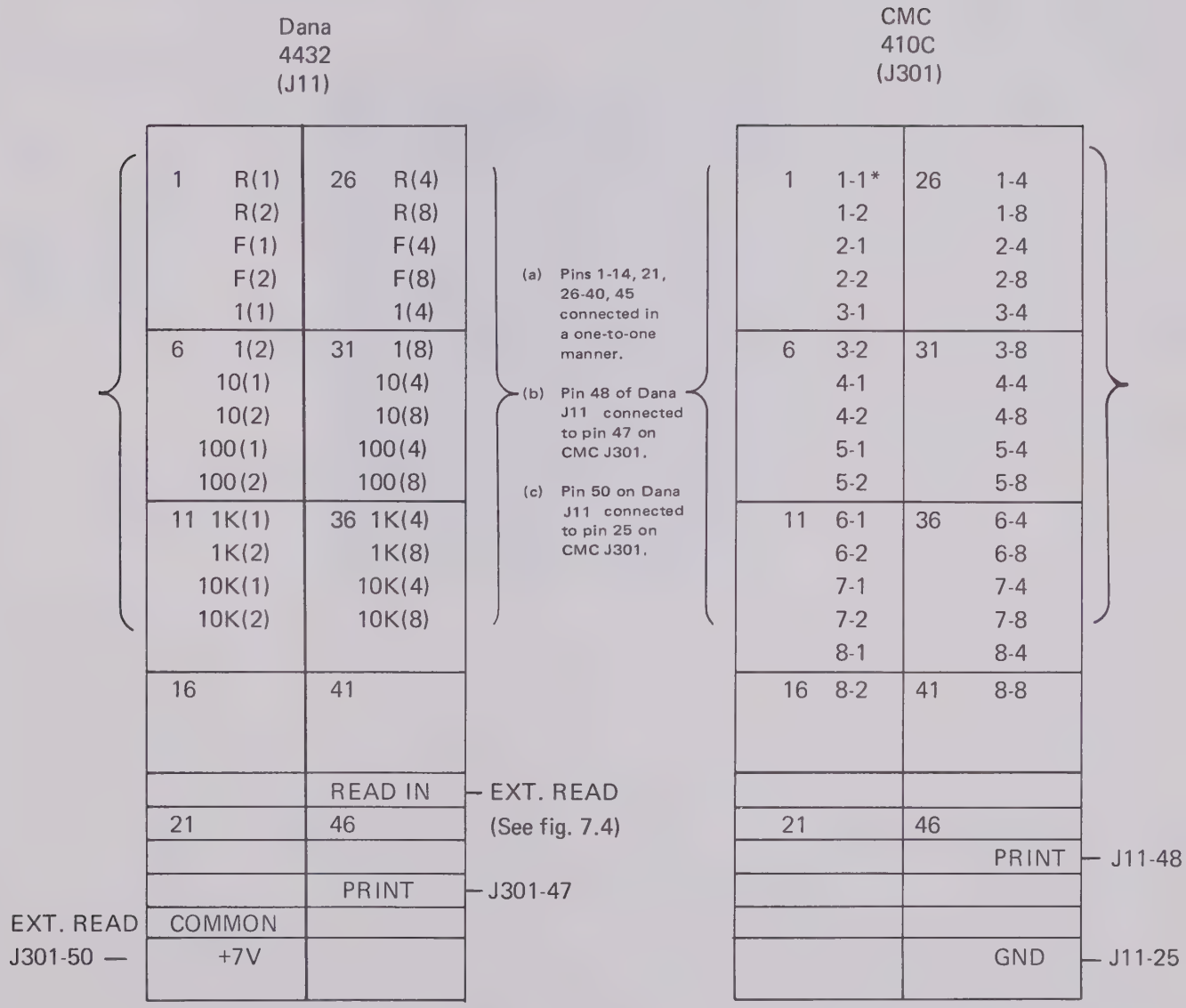
7.21 DATA PRESENTATION. The 4432 output will appear as follows:

Column 1 - decimal number indicating range
Column 2 - decimal number indicating function/polarity
Column 3 - Most significant digit (overrange bit)
Column 4 - Second most significant digit
Column 5 - Third most significant digit
Column 6 - Fourth most significant digit
Column 7 - Least significant digit

NOTE: The read command line of the 4432 (pin 45) appears on a data line for column 10 on the HP-5050 printer. Since only seven columns are required for the 4432, column 10 is not used. If the printer has a column 10, operation of the printer will not be affected, since the command level is zero at the time of the print pulse.

7.22 CMC 410A

7.23 Interfacing. A slight modification from a standard "one-to-one" cable is required to interface the 4432 with the CMC 410A printer (refer to figure 7.6).



* 1-1 means printer column 1, 2^0 = 1 bit
3-4 means printer column 3, 2^2 = 4 bit

Figure 7.6. 4432/CMC 410A Interconnecting Cable

7.24 The 410A interconnecting cable will develope a "negative-level," positive true data interface. (Refer to CMC 410A manual, option 4a.) An external read command can be applied to the 4432, as shown in figures 7.4 and 7.5.

DC SETTLING TIME WITH RESPECT TO SOURCE RESISTANCE - (4400 Series)

Source Resistance	To .01%
0	500 ms
10K	670 ms
20K	790 ms
30K	920 ms
50K	1.1 sec
100K	1.7 sec
200K	2.7 sec
300K	3.7 sec
500K	4.4 sec
1 meg	10.0 sec

7.25 Data and Presentation. Same as HP562A/5050A. As the 4432 cannot drive the printer decimal lines directly, the range information will appear on the first column.

7.26 TIMING INFORMATION

Maximum digitizing time - 18 milliseconds
Full scale step function
settling time to .01% - dc - .5 sec
ac - 2 sec
ohms -
1K - 1 meg - 1 sec
10 meg - 10 sec
Recycle Time 25 milliseconds
Maximum Read Rate 22 readings/sec

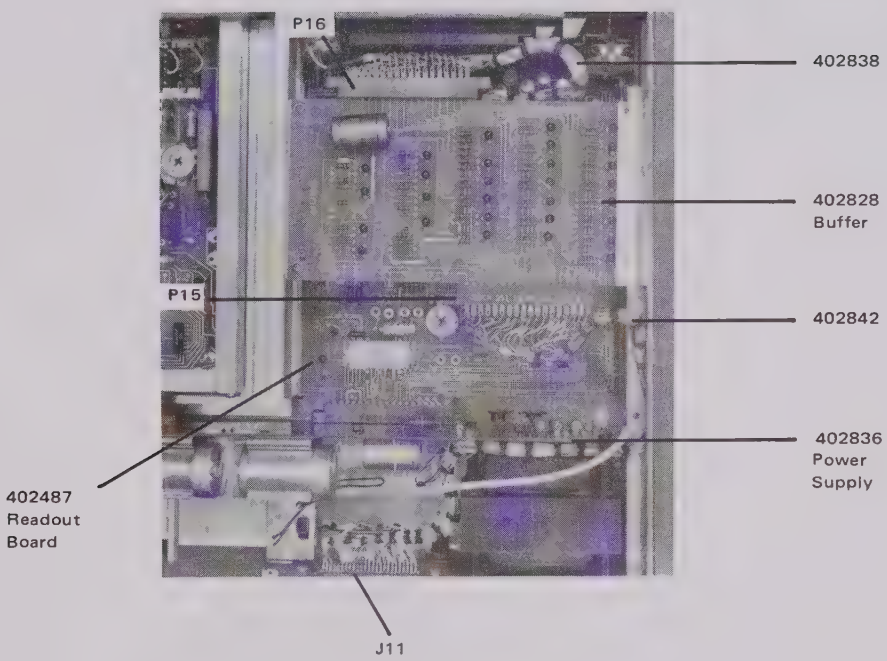
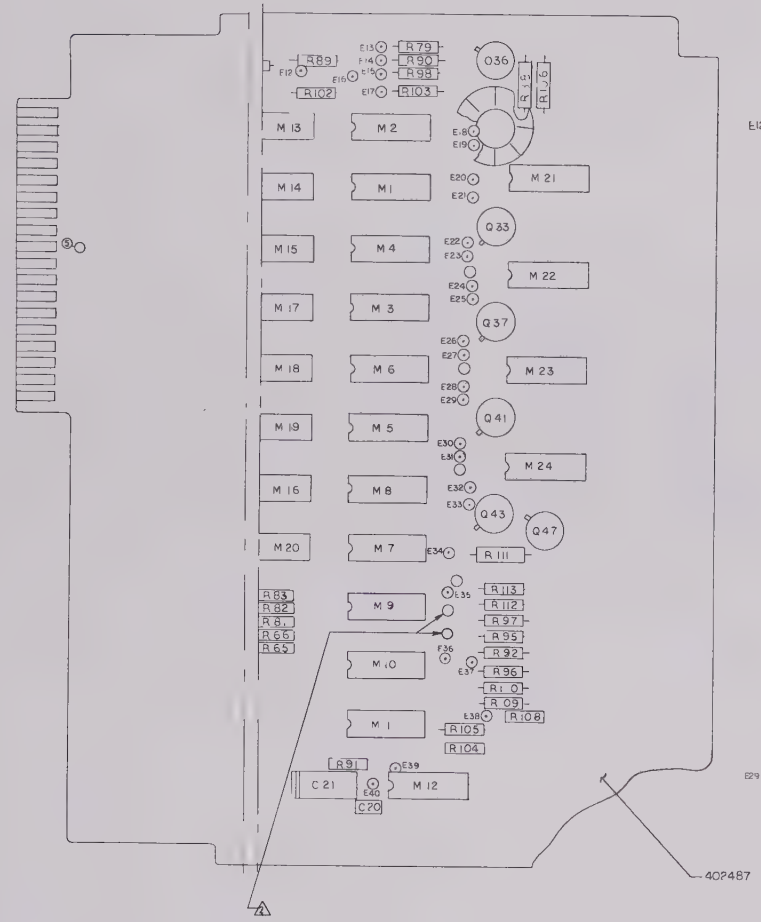
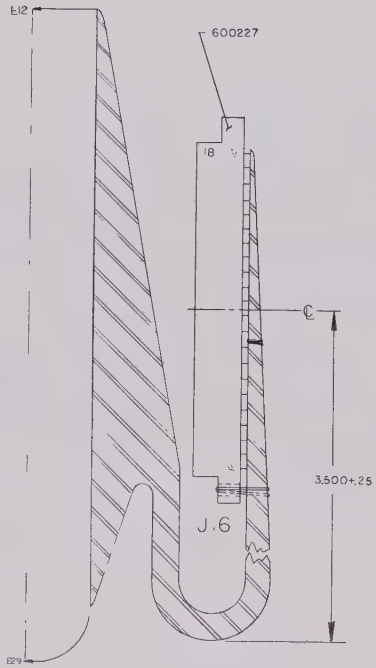


Figure 7.7 (BCD Output Interconnection Diagram)

DRAWINGS - OUTPUT OPTION 4432

Input Cable Assembly	402838
Output Buffer Assembly	402828
Output Buffer Schematic	430804
Cable Harness	402842
Power Supply	402836





FROM	TO	CONDUCTOR TYPE, COLOR	P/N	WIRE LGTH	CIRCUIT LOCATION
E-12	J18-S	9-1	524819		P1-M
E-13	J18-N	9-2	524820		P1-V
E-14	J18-P	9-3	524838		P1-18
E-15	J18-R	9-8	524836		P1-17
E-16	J18-10	9-1-0	524810		P1-10
E-17	J18-9	9-1-1	524811		P1-U
E-18	J18-8	9-1-2	524812		M2-14
E-19	J18-4	9-1-3	524813		M2-8
E-20	J18-5	9-1-4	524814		M1-14
E-21	J18-C	9-1-5	524815		M1-8
E-22	J18-2	9-1-6	524816		M4-14
E-23	J18-1	9-1-7	524817		M4-8
E-24	J18-3	9-1-8	524818		M3-14
E-25	J18-A	9-2-0	524820		M3-8
E-26	J18-8	9-2-1	524821		M6-14
E-27	J18-E	9-2-2	524822		M6-8
E-28	J18-F	9-2-3	524823		M5-14
E-29	J18-6	9-2-4	524824		M5-8
E-30	J18-13	9-2-5	524825		M8-14
E-31	J18-6	9-2-6	524826		M8-8
E-32	J18-D	9-2-7	524827		M7-14
E-33	J18-7	9-2-8	524828		M7-8
E-34	J18-H	9-3-0	524830		M9-14
E-35	J18-J	9-3-1	524831		M9-8
E-36	J18-U	9-3-2	524832		P1-L
E-37	J18-11	9-3-4	524834		P1-H
E38	J18-T	9-3-5	524835		M10-9
E-39	J18-12	9-3-8	524838		M12-14
E-40	J18-14	9-1	524812		M12-3

QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.
AR	SEE W RELIST	WIRE 24 GA TEFLON COATED			4
AR	920026	SOLDER-WIRE .03263/37 RESIN CORE			3
1	600227	CONNECTOR, CINCH		251-18-30-160	2
1	402487	ASSEMBLY - READOUT BOARD			1

2. TIE HARNESS SECURELY TO BOARD AT THESE EXISTING HOLES WITH LACING CORD.

1. COMPONENTS SHOWN ARE FOR REF. LOCATION WIRING HARNESS ONLY.

NOTES: UNLESS OTHERWISE SPECIFIED

402839	4432	1	1
NEXT DWG	USED ON	NEXT DWG	FINAL ASSY
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON: DECIMALS X .030 XX .020 XXX .010 | ANGLES 0 30' | HOLE DIAMETERS +.004 -.001

MATERIAL

FINISH

DRAWN P. Brummett 9-8-78
CHECK
DESIGN P. Brummett 9-8-78
MECH ENGR
PROJ ENGR W. R. Hall 10-24-78

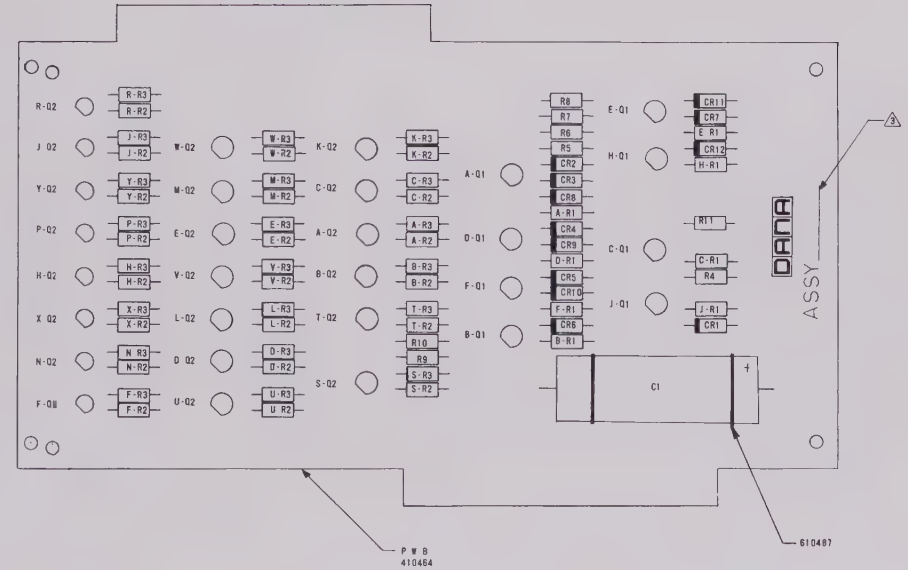
DRN 797

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ASSEMBLY
RF ADOUT BOARD-INPUTCABLE

SIZE	CODE IDENT NO	DWG NO.	REV
D	21793	402838	A

SCALE 2/1 SHEET 1 OF 1



■ FOR PARTS LIST SEE SHEET 3

3 RUBBER STAMP TOP ASSY NO. AND LATEST REV. LETTER IN APPROXIMATE AREAS SHOWN (NEARSIDE).

2. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM TO DANA WORKMANSHIP STANDARDS

1. FOR SCHEMATIC SEE: 430804

NOTES: UNLESS OTHERWISE SPECIFIED

402885	4432	REF	REF
NEXT DWG	USED ON	NEXT DWG	FINAL ASSY
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON:
DECIMALS: X .030, XX .020, XXX .010 | ANGLES: 0 30' | FORMED 1 0' | HOLE DIAMETERS: +.004 -.001

MATERIAL

FINISH

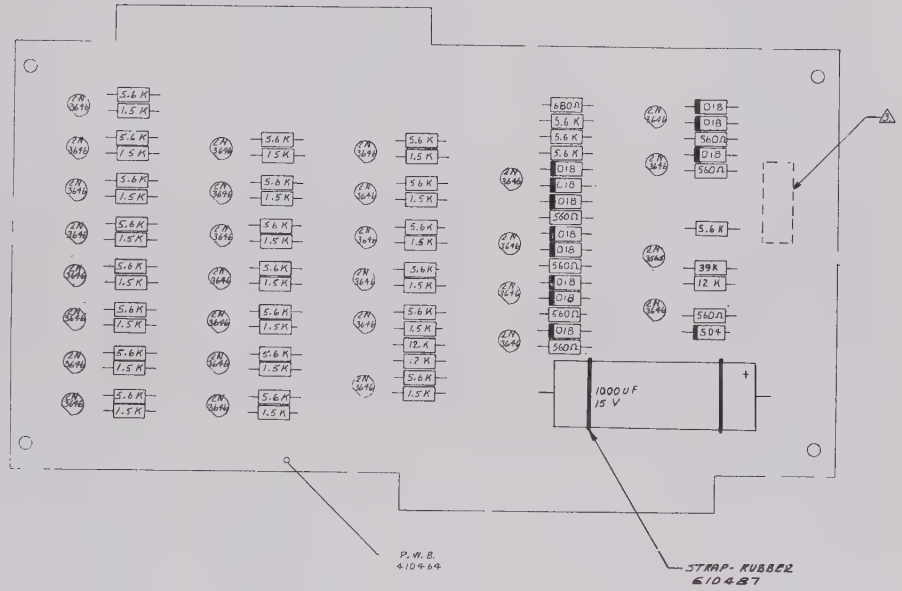
DRAWN P. Haslam 7/8/68
CHECK 7/8/68
DESIGN
MECH ENGR
PROJ ENGR
DRN 797

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ASSY - OUTPUT BUFFER

SIZE	CODE IDENT NO	DWG NO.	REV
D	21793	402828	B

SCALE 2:1 SHEET 1 OF 3



4. FOR PARTS LIST SEE SHEET 3
3. RUBBER STAMP TOP ASSY NO AND LATEST REV LETTER IN APPROXIMATE AREAS SHOWN (NEARSIDE).
2. ASSEMBLY PRECEDURES AND PROCESSES TO CONFORM TO DANA WORKMANSHIP STANDARDS.
1. FOR SCHEMATIC SEE : 430804

NOTES: UNLESS OTHERWISE SPECIFIED

402839	4432	REF	REF
NEXT DWG	USED ON	NEX. DWG	FINAL ASST
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON:
DECIMALS ANGLES HOLE DIAMETERS
X .030 0 30' .004
XX .020 FORMED .001
XXX .010 1 0'
MATERIAL
FINISH

DRAWN P. Hanlon 7/8/68
CHECK
DESIGN
MECH ENGR
PROJ ENGR
DRN 79

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ASSY - OUTPUT BUFFER

SIZE	CODE IDENT NO	DWG NO.	REV
D	21793	402828	A

SCALE 2:1 SHEET 2 OF 3

REF DES OR ITEM	P/N	DESCRIPTION	QTY
C1	110077	CAP 1000UF/15V	1
CR1	210004	DIODE SD4	1
CR2	211083	DIODE 018	11
CR3	211083	DIODE 018	REF
CR4	211083	DIODE 018	REF
CR5	211083	DIODE 018	REF
CR6	211083	DIODE 018	REF
CR7	211083	DIODE 018	REF
CR8	211083	DIODE 018	REF
CR9	211083	DIODE 018	REF
CR10	211083	DIODE 018	REF
CR11	211083	DIODE 018	REF
CR12	211083	DIODE 018	REF
A-Q1	200037	TRANSISTOR 2N3646	28
B	200037	TRANSISTOR 2N3646	REF
C	200043	TRANSISTOR 2N3565	1
D	200037	TRANSISTOR 2N3646	REF
E	200037	TRANSISTOR 2N3646	REF
F	200037	TRANSISTOR 2N3646	REF
H	200037	TRANSISTOR 2N3646	REF
J	200037	TRANSISTOR 2N3646	REF
A-Q2	200037	TRANSISTOR 2N3646	REF
B	200037	TRANSISTOR 2N3646	REF
C	200037	TRANSISTOR 2N3646	REF
D	200037	TRANSISTOR 2N3646	REF
E	200037	TRANSISTOR 2N3646	REF
F	200037	TRANSISTOR 2N3646	REF
H	200037	TRANSISTOR 2N3646	REF
J	200037	TRANSISTOR 2N3646	REF
A-R1	000561	RESISTOR 560	7
B	000561	RESISTOR 560	REF
C	000393	RESISTOR 39k	1
D	000561	RESISTOR 560	REF
E	000561	RESISTOR 560	REF
F	000561	RESISTOR 560	REF
H	000561	RESISTOR 560	REF
J	000561	RESISTOR 560	REF

TITLE OUTPUT BUFFER SHEET ___ OF ___

MODEL ___ REV. DATE ___ DWG NO. 402828 REV. ___

REF DES OR ITEM	P/N	DESCRIPTION	QTY
A-R2	000152	RESISTOR 1.5k	21
B	000152	RESISTOR 1.5k	REF
C	000152	RESISTOR 1.5k	REF
D	000152	RESISTOR 1.5k	REF
E	000152	RESISTOR 1.5k	REF
F	000152	RESISTOR 1.5k	REF
H	000152	RESISTOR 1.5k	REF
J	000152	RESISTOR 1.5k	REF
K	000152	RESISTOR 1.5k	REF
L	000152	RESISTOR 1.5k	REF
M	000152	RESISTOR 1.5k	REF
N	000152	RESISTOR 1.5k	REF
P	000152	RESISTOR 1.5k	REF
R	000152	RESISTOR 1.5k	REF
S	000152	RESISTOR 1.5k	REF
T	000152	RESISTOR 1.5k	REF
U	000152	RESISTOR 1.5k	REF
V	000152	RESISTOR 1.5k	REF
W	000152	RESISTOR 1.5k	REF
X	000152	RESISTOR 1.5k	REF
Y	000152	RESISTOR 1.5k	REF
A-R3	000562	RESISTOR 5.6k	25
B	000562	RESISTOR 5.6k	REF
C	000562	RESISTOR 5.6k	REF
D	000562	RESISTOR 5.6k	REF
E	000562	RESISTOR 5.6k	REF
F	000562	RESISTOR 5.6k	REF
H	000562	RESISTOR 5.6k	REF
J	000562	RESISTOR 5.6k	REF
K	000562	RESISTOR 5.6k	REF
L	000562	RESISTOR 5.6k	REF
M	000562	RESISTOR 5.6k	REF
N	000562	RESISTOR 5.6k	REF
P	000562	RESISTOR 5.6k	REF
R	000562	RESISTOR 5.6k	REF
S	000562	RESISTOR 5.6k	REF
T	000562	RESISTOR 5.6k	REF
U	000562	RESISTOR 5.6k	REF
V	000562	RESISTOR 5.6k	REF
W	000562	RESISTOR 5.6k	REF
X	000562	RESISTOR 5.6k	REF
Y	000562	RESISTOR 5.6k	REF
R4	000123	RESISTOR 12k	3
R5	000562	RESISTOR 5.6k	REF
R6	000562	RESISTOR 5.6k	REF
R7	000562	RESISTOR 5.6k	REF
R8	000681	RESISTOR 680	1
R9	000123	RESISTOR 12k	REF
R10	000123	RESISTOR 12k	REF
R11	000562	RESISTOR 5.6K	REF
1	410484	PWB OUTPUT BUFFER	1
3	430804	SCHEMATIC	REF
	610487	STRAP-RUBBER	2

TITLE OUTPUT BUFFER SHEET ___ OF ___

MODEL ___ REV. DATE ___ DWG NO. 402828 REV. ___

NEXT DWG	USED ON	NEXT DWG	FINAL ASSY
402839	4432	REF	REF
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
DECIMALS .X .030 .XX .020 .XXX .010
ANGLES 0 30' FORMED 1° 0'
HOLE DIAMETERS +.004 −.001

MATERIAL

FINISH

DRAWN	F. Sabol	22 May 1968
CHECK		
DESIGN		
MECH ENGR	J. Williams	6-10-68
PROJ ENGR	D. Robillard	6/6

DRN 797

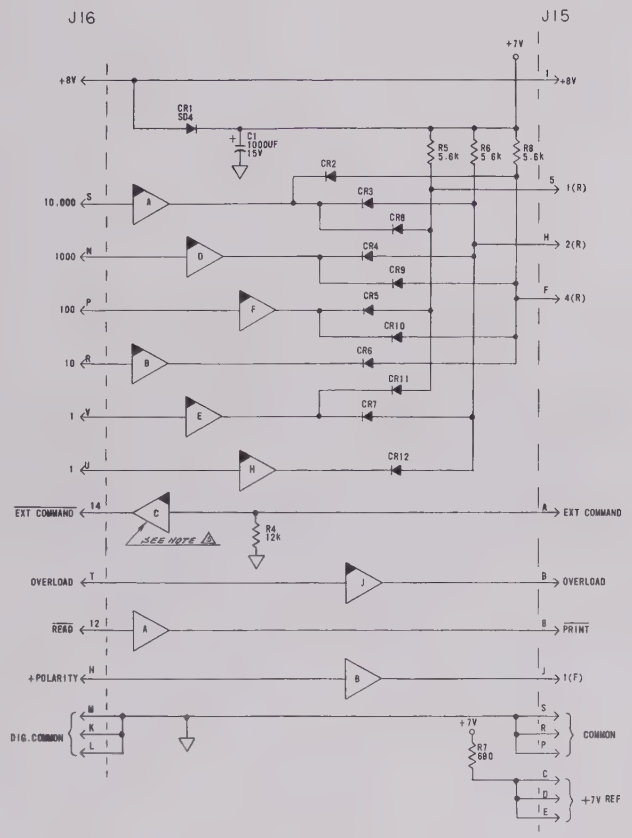
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

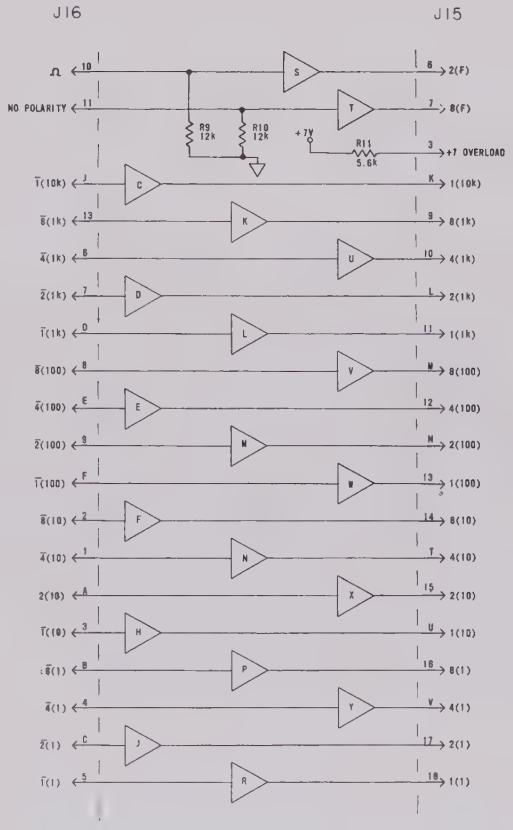
ASSY—
OUTPUT BUFFER

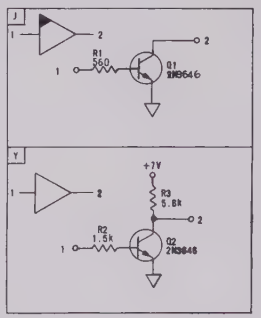
SIZE	CODE IDENT NO.	DWG NO.	REV
C	21793	402828	B

SCALE NONE SHEET 3 OF 3

NOTES: UNLESS OTHERWISE SPECIFIED







6. THIS SYMBOL ▽ INDICATES DIGITAL COMMON
5. AS AN EXCEPTION MODULE E1 DIGL MAY'E R1 39k & Q1 2N3565
4. HIGHEST REFERENCE DESIGNATOR USED ARE C1, CR12, R10, Q2
3. ALL RESISTORS ARE CARBON 1/4W 5%
2. ALL TRANSISTORS ARE 2N3646
1. ALL DIODE ARE D18

NOTES: UNLESS OTHERWISE SPECIFIED

402828	4432	REF	REF
NEXT DWG	USED ON	NEXT DWG	FINAL ASSY
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
DECIMALS: X .030, XX .020, XXX .010 | ANGLES: 0° 30' FORMED, 1° 0" | HOLE DIAMETERS: + .004, - .001
MATERIAL
FINISH

DRAWN	P. Nielsen	7/68
CHECK		7/68
DES GN		
MECH ENGR		
PROJ ENGR		7-2-68

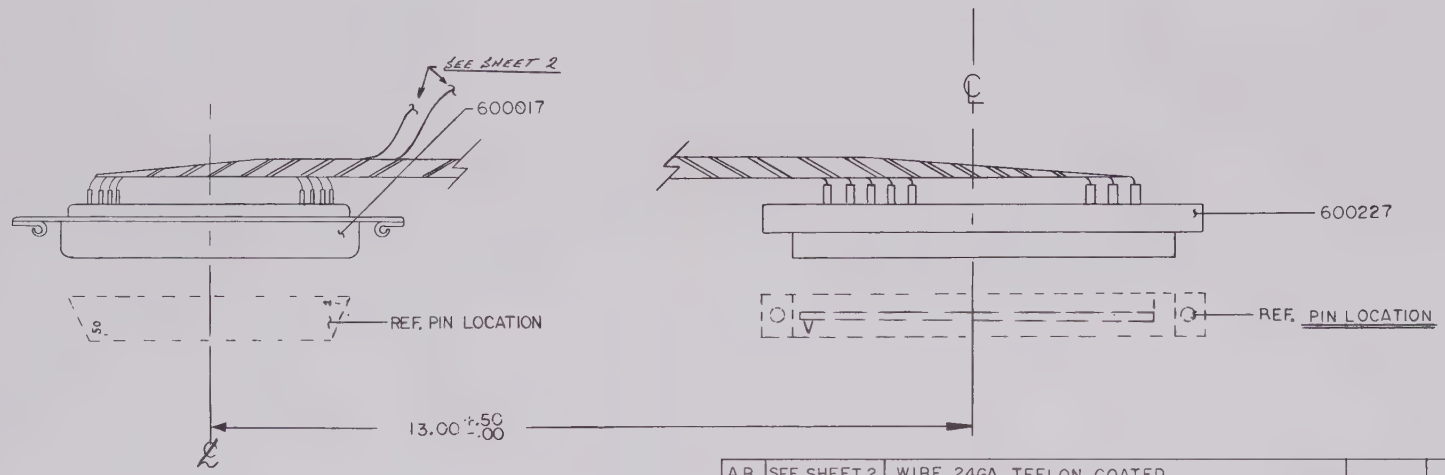
DRW 32

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC -
OUTPUT BUFFER

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	430804	

SCALE NONE | SHEET 1 OF 1



QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.
		LIST OF MATERIAL OR PARTS LIST			
A R	SEE SHEET 2	WIRE 24GA TEFLON COATED			4
A R	920026	SOLDER-WIRE .03263/37 RESIN CORE			3
1	600227	CONNECTOR, CINCH		251-18-30-160	2
1	600017	CONNECTOR, AMPHENOL 57 SERIES MICRO RIBBON			1

APPLICATION		QTY REQD	
NEXT DWG	USED ON	NEXT DWG	FINAL ASSY
402836	4432	1	1

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON:

DECIMALS	ANGLES	HOLE DIAMETERS
.X .030	0° 30'	+.004
.XX .020	FORMED	-.001
.XXX .010	1° 0'	

MATERIAL

FINISH

DRAWN	P. Haslam	5/6/68
CHECK	P. Zimmerman	5/14/68
DESIGN	P. Zimmerman	5/14/68
MECH ENGR		6-10-68
PROJ ENGR	W. Dibble	6/14

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

CABLE HARNESS BUFFER UNIT

SIZE	CODE IDENT NO.	DWG NO.	REV
C	21793	402842	

SCALE NONE SHEET 1 OF 2

NOTES: UNLESS OTHERWISE SPECIFIED

1. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM WITH DANA WORKMANSHIP STANDARDS
2. SCHEMATIC REF 430804
3. SEE FOR WIRING LIST SHEET 2.

FROM	TO	CONDUCTOR TYPE, COLOR	P/N	WIRE LGTH	NOTES
J14-10	J15-N	9-1-5	524915		
J14-1	J15-5	9-1	524919		
J14-2	J15-H	9-2	524929		
J14-3	J15-J	9-3	524939		
J14-4	J15-6	8-9	524898		
J14-5	J15-18	9-1-0	524910		
J14-6	J15-17	9-1-1	524911		
J14-7	J15-U	9-1-2	524912		
J14-8	J15-15	9-1-3	524913		
J14-9	J15-13	9-1-4	524914		
J14-11	J15-11	9-1-6	524916		
J14-12	J15-L	9-1-7	524917		
J14-13	J15-K	9-1-8	524918		
J14-14	J15-R	9-2-0	524920		
J14-17	J15-B	9-2-1	524921		
J14-24	J15-S	9-2-2	524922		
J14-25	J15E	9-2-3	524923		
J14-26	J15-F	9-2-4	524924		
J14-27	J15-P	9-2-5	524925		
J14-28	J15-P	9-2-6	524926		
J14-29	J15-7	9-2-7	524927		

FROM	TO	CONDUCTOR TYPE, COLOR	P/N	WIRE LGTH	NOTES
J14-30	J15-V	9-2-8	524928		
J14-31	J15-16	9-3-0	524930		
J14-32	J15-T	9-3-1	524931		
J14-33	J15-14	9-3-2	524932		
J14-34	J15-12	9-3-4	524934		
J14-35	J15-M	9-3-5	524935		
J14-36	J15-10	9-3-6	524936		
J14-37	J15-9	9-1	524919		
J14-38	J15-R	9-2	524929		
J14-39	J15-R	9-3	524939		
J14-45	J15-A	8-9	524898		
J14-46	J15-8	9-1-0	524910		
J15-3	J15-B	9-2-0	524920		
J15-S	E11 (SEE NOTE)	9-1	524922		COMMON
J15-1	E12 (SEE NOTE)	9-0-9	524909		+8V

1. SEE 402836 FOR WIRE LOCATION. (E11 & E12)

NOTES: UNLESS OTHERWISE SPECIFIED

402836	4432	1	1
NEXT DWG	USED ON	NEXT DWG	FINAL ASSY
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
DECIMALS .X .030 .XX .020 .XXX .010 | ANGLES 0 30' FORMED 1 0' | HOLE DIAMETERS +.004 -.001

MATERIAL

FINISH

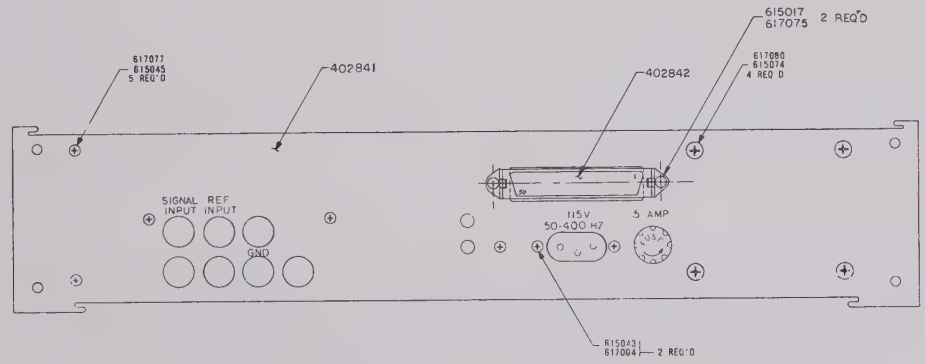
DRAWN	P. Haslam	5/6/68
CHECK		
DESIGN		5/14/68
MECH ENGR		6-10-68
PROJ ENGR		6/14

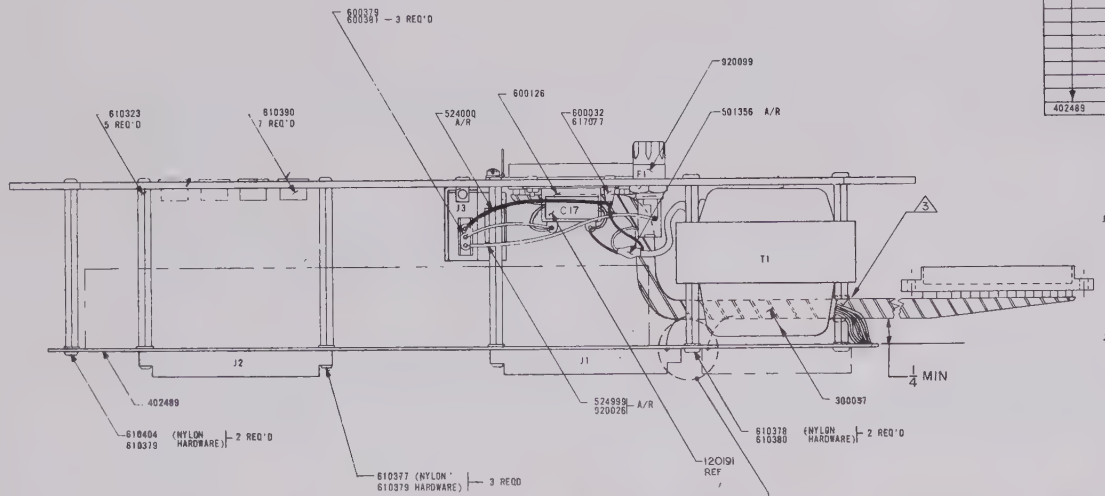
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

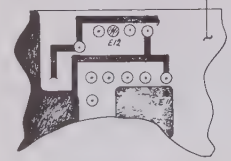
CABLE HARNESS
BUFFER UNIT

SIZE	CODE IDENT NO	DWG NO.	REV
C	21793	402842	

SCALE NONE | SHEET 2 OF 2



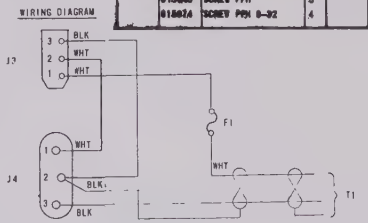




VIEW ONLY USED FOR WIRING PURPOSE. (SEE SHEET 2 OF 402842)

WIRE LIST			
402489	E#	COLOR	T1
	2	GY	
	9	BLU	
	3	VIO	
	4	BRN	
	8	GRN	
	6	ORG	
	7	YEL	
	10	BLK	
	5	RED	
402489	1	WHT	T4

WIRING DIAGRAM



QTY REQ'D	P/N	DESCRIPTION	QTY	REF DES	P/N	DESCRIPTION	QTY
C17	120101	CAP 22UF/400V	1		617006	HEX NUT 4-40	2
	300037	XSFR PWR	1		617075	WASH INT LOCK 2	2
	402489	PCB ASSY PWR SUP	1		617077	WASH INT LOCK 4	6
	402841	PANEL REAR ASSY	1		617080	WASH INT LOCK 6	4
	402842	CABLE HARNESS	1		929925	[illegible]	A/R
	430877	SCHEMATIC PWR SUP	A/R		930009	FUSEHOLD	1
	501356	SHRINK TUBING	A/R				
	524000	WIRE-G COLOR	A/R				
	524999	WIRE-G COLOR	A/R				
	600032	LUG SOLDER	1				
	600126	RECP AC PCB	1				
	600379	CONN RECP	1				
	600381	PIN RECP	3				
	610323	STOF NO.6-32 1/4 HEX X 3 LG AL	5				
			2				
	610377	SCREW-NYLON 4-40	3				
	610378	SCREW-NYLON 6-32	2				
	610379	WASH-NYLON NO. 4	5				
	610380	WASH-NYLON NO.6	2				
	610390	PLUG-HOLE	7				
	610404	SCREW-NYLON 4-40	2				
	615017	SCREW 2-56 X 7/16	2				
	615043	SCREW PPH 4-40	2				
	615045	SCREW PPH	5				
	616074	SCREW PPH 8-32	4				

A. SECURE CABLE TO SPACER WITH LACING CORD
B. SCHEMATIC REF.: NO 430877
C. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM WITH DANA WORKMANSHIP STANDARDS.
BODY UNLESS OTHERWISE SPECIFIED

402839	4432	1	1
NEXT ASSY	USED ON	NA	FA
APPLICATION		QTY REQD	

QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.
		LIST OF MATERIAL OR PARTS LIST			

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON: DECIMALS | ANGLES | FORMED ANGLES
X .030 | 0° 30' | 1.0
XX .020
XXX .010
MATERIAL
FINISH

CONTRACT NO.

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

DRAWN 5-9-66
CHECK 5-9-66
DESIGN
PROJ ENGR 6-10-66

POWER SUPPLY ASSY
FULL RACK

SIZE D | CODE IDENT NO. 21793 | DWG NO. 402836 | REV A

SCALE 1/1 | WT | SHEET 1 OF 1

DRW797

Warranty

It is the practice of Dana Laboratories, Incorporated, to manufacture only products of a quality that will merit customer satisfaction. The company recognizes that customer satisfaction is achieved, not only by delivering products meeting advertised performance specifications and having a high level of reliability, but also by honestly and efficiently fulfilling their warranty obligations as set forth below.

Dana Laboratories, Inc., agrees to correct, either by repair or replacement, any defect of material or workmanship in Dana-manufactured units or components which develop within one year after delivery of the equipment to the original purchaser — provided that the equipment has been subjected only to normal and proper use.

In the event of failure of any component delivered with Dana equipment, but not manufactured by Dana Laboratories, assistance will be given the customer in obtaining, from the original manufacturer, reasonable adjustment under that manufacturer's warranty.

Any item claimed to be defective during the warranty period must be returned to Dana Laboratories, Inc., with transportation charges prepaid. The item will be repaired and returned to the purchaser with return transportation prepaid by Dana unless, of course, the item is found not to be defective or found to be damaged by misuse — in which case it will be returned to the purchaser with repair and transportation billed collect.

DANA

DANA™

www.manualsplus.com
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